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THE ARTIZAN

ENGINEERING JOURNAL

VOL 1 THIRD SERIES

VOL XXI OLD SERIES

STEAM NAVIGATION SHIP BUILDING AND THE APPLICATION OF CHEMISTRY TO THE INDUSTRIAL ARTS

A MONTHLY RECORD of the PROGRESS of CIVIL and MECHANICAL ENGINEERING

ESTABLISHED 1843.

EDITED BY W. SMITH C.E. F.C.S F.C.S. F.R.G.S &c.

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THE ARTIZAN:

A Monthly Record of the Progress

OF

CIVIL AND MECHANICAL ENGINEERING,

SHIPBUILDING, STEAM NAVIGATION, THE APPLICATION OF CHEMISTRY TO THE INDUSTRIAL ARTS, &c.

EDITED BY WM. SMITH, C.E.

F.G.S., F.C.S., F.R.G.S., &c.

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THE ARTIZAN JOURNAL, 1863.

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LIST OF PLATES.

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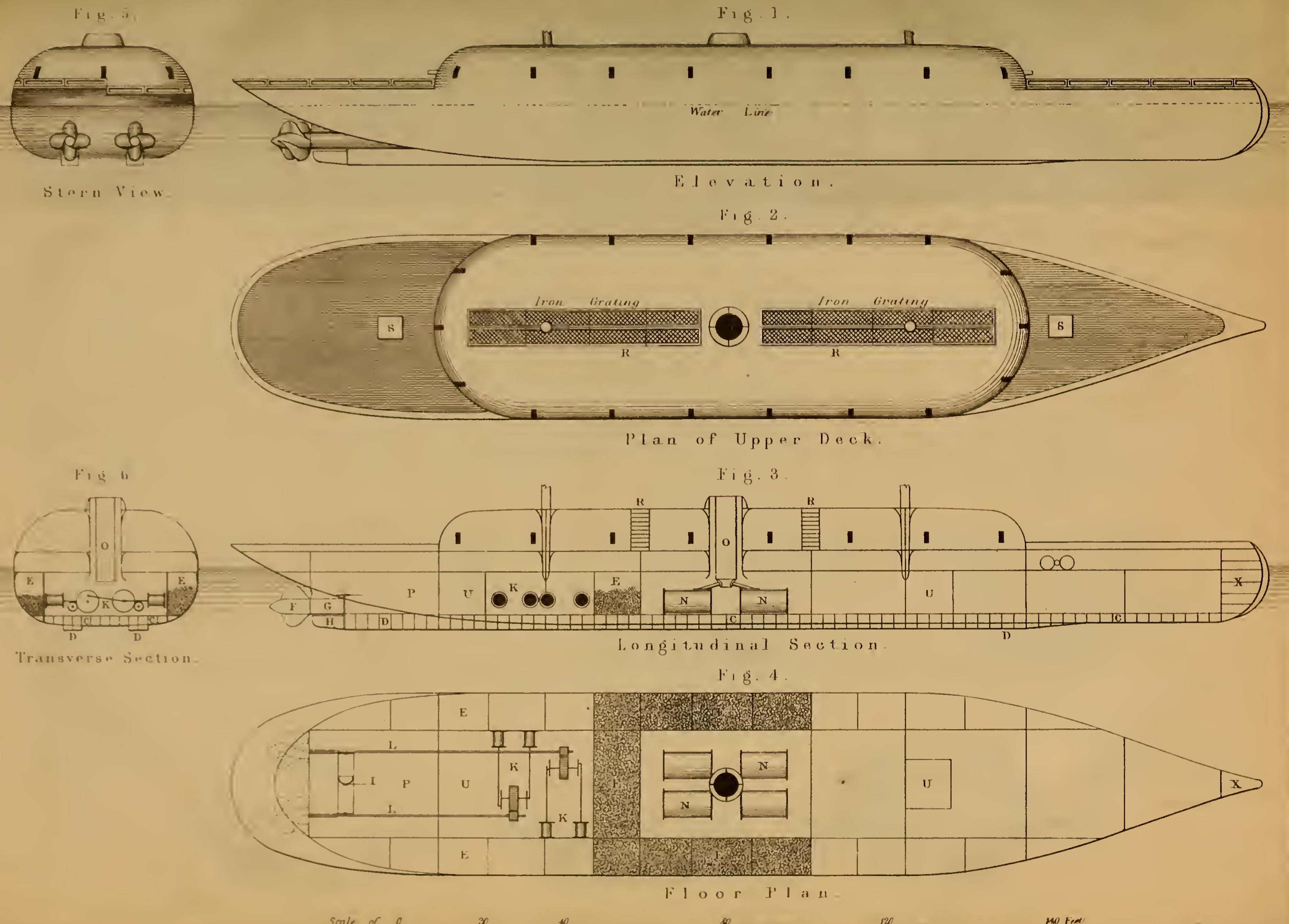
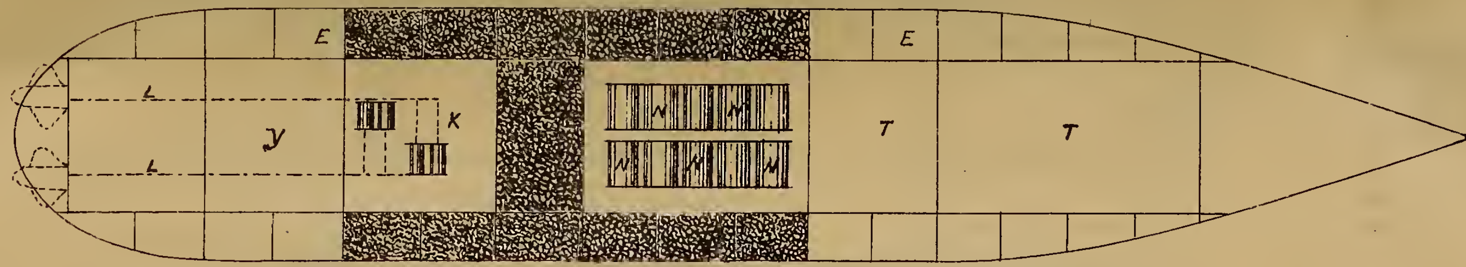
BY AN EMINENT PATENT-LAW BARRISTER.

ARMOUR PLATED LIGHT DRAUGHT COAST DEFENCE SHIP. 14 GUNS.



PASSENGER OR TROOP SHIP.

FIG. 1.



Floor Plan showing Cellular arrangement of the Coal-Bunkers.

FIG. 2.

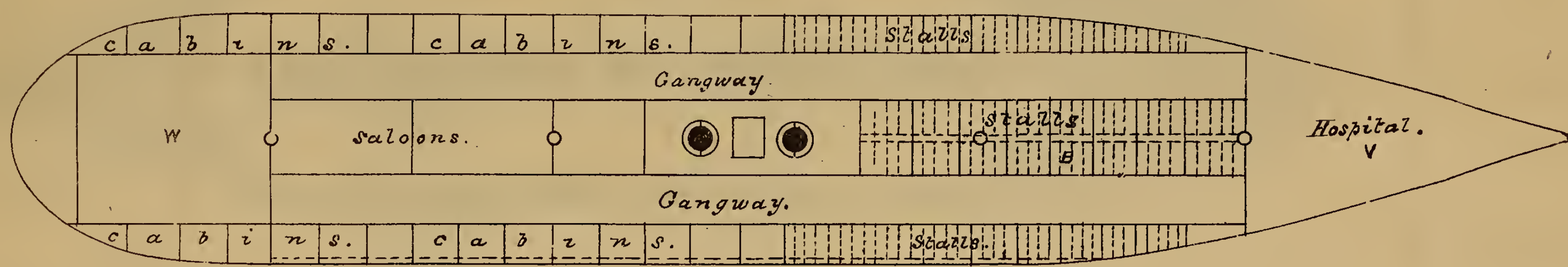
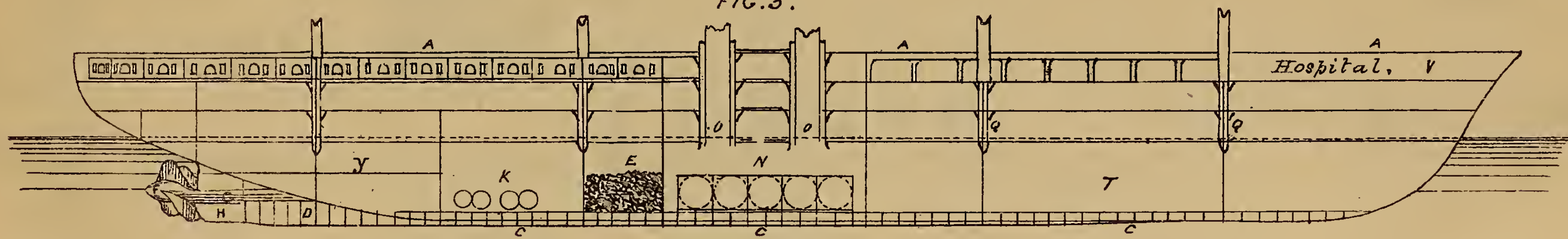


FIG. 3.



Stern View showing non-fouling Propellers and Rudders.

FIG. 4.

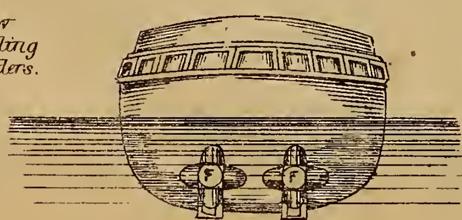


FIG. 5.

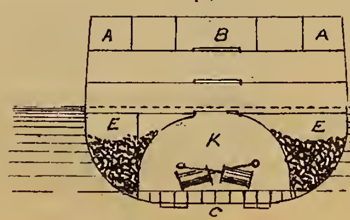
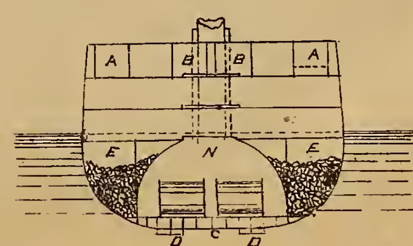
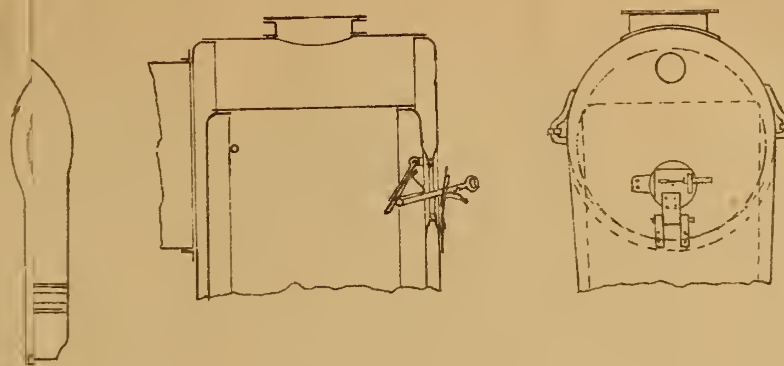


FIG. 6.



50 25 0 50 100 150 200 250 Feet.

FIG. 9.



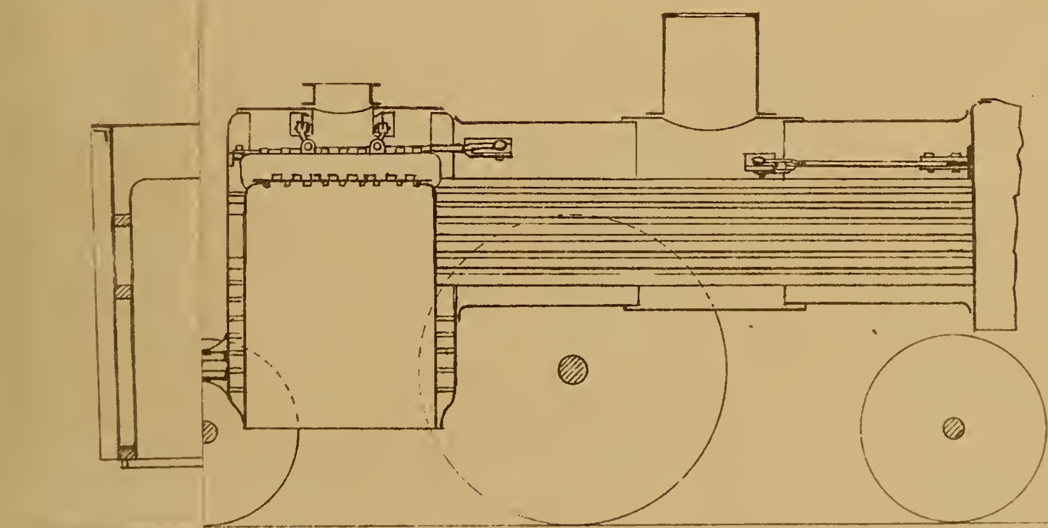
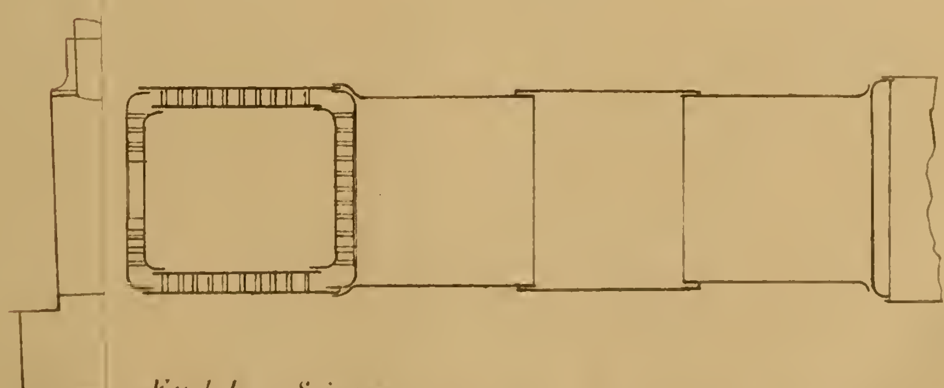


FIG. 10.



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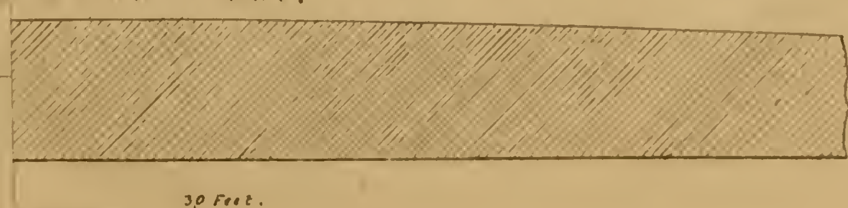


30 Feet.

LOCOMOTIVE ENGINEERING.

Fig. 1.

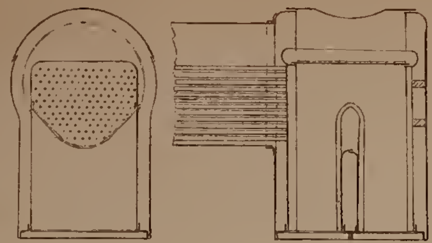


Fig. 2.

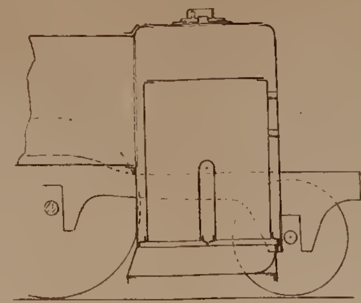


Fig. 3.

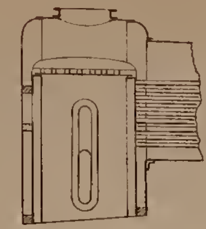


Fig. 4.

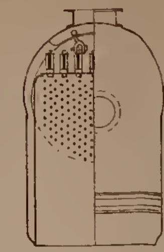


Fig. 9.

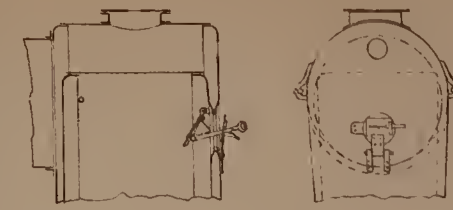


Fig. 5.

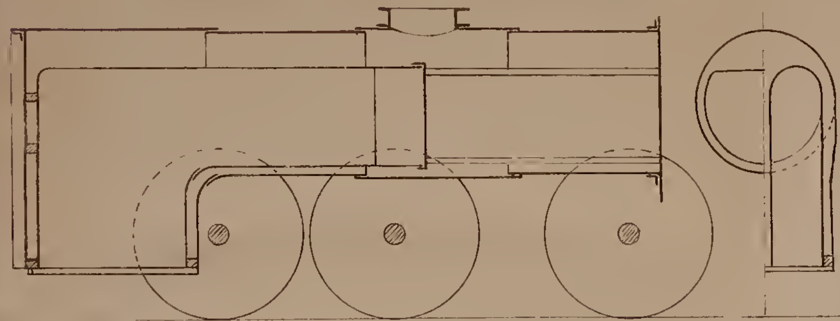
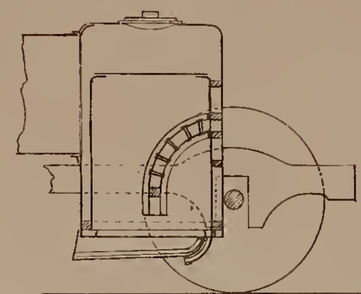


Fig. 6.



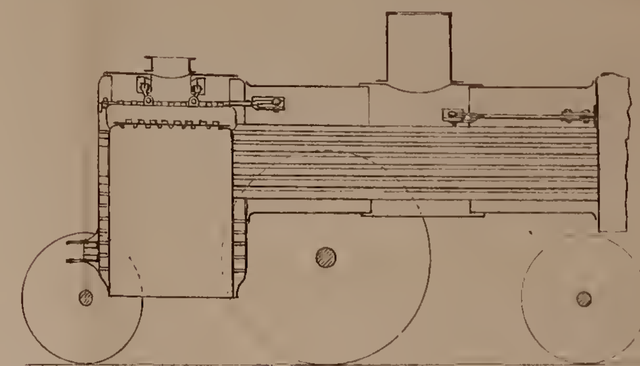


Fig. 7.

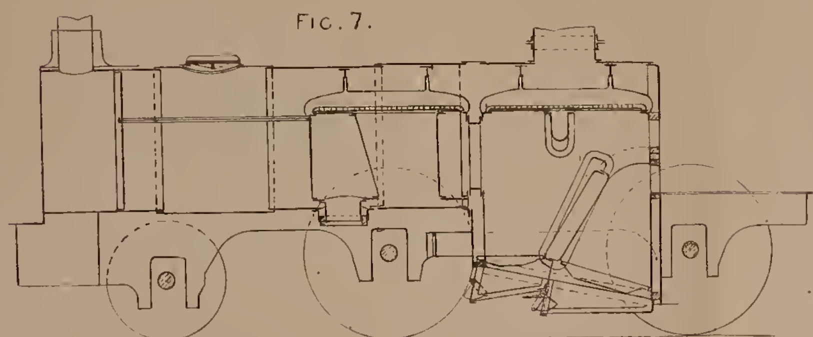


Fig. 8.

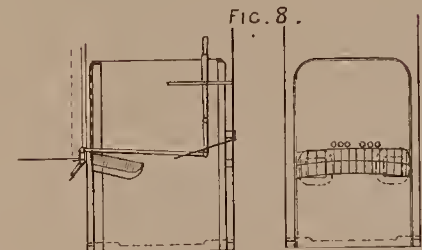
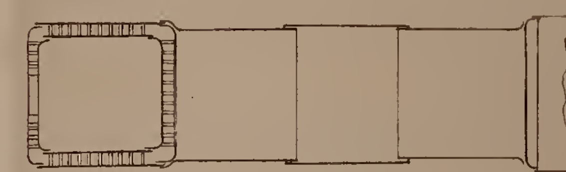


Fig. 10.



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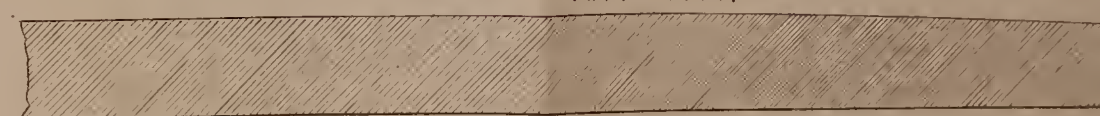


THE ARTIZAN.

No. 1.—Vol. 1.—Third Series.

JANUARY 1st, 1863.

"ARTIZAN" ADDRESS, 1863.

With the present number we commence the first volume of the third series of the Artizan, and the twenty-first volume from the commencement.

During the past twenty years we believe that the Artizan has proved more thoroughly useful, because of a more practical and utilitarian character, than any of its contemporaries; and no scientific journal has more faithfully performed the task originally undertaken, or from time to time imposed, and we have but to invite the perusal of the published numbers of the Artizan to justify most fully our assertion.

On previous occasions we have, at the advent of the new year, given in our annual address a brief summary of the more important events which have occured during the previous twelve months; upon the present occasion we think it only necessary to refer our readers to the pages of the Artizan itself for the best epitome of all that is material or useful which has occurred during the year just closed, and this we are enabled to do from the improvements which have recently been effected in the body of the work, by which greater space has been obtained for a monthly summary of events, and an increase in the number of scientific papers and reports, which we have thus been enabled to admit; we have also the gratification of being able to direct attention to the increased number of illustrations which we have given of highly-interesting subjects during the past year.

The publication of a series of supplements, illustrating the most novel and interesting of the objects exhibited at the International Exhibition, has enabled us to describe and illustrate very many subjects, without encroaching upon the space of our regular issue.

The International Exhibition of 1862, has been the great event of the year, and doubtless would have been a much greater success, in every respect, but for the much lamented death of his Royal Highness the Prince Consort, the deplorable internecine war raging in America, and the great distress which has been produced amongst the operatives of the great cotton spinning district of this country, from the want of the raw material —cotton.

Of the various Scientific Societies whose proceedings we usually report, the Institution of Civil Engineers, during the last session, produced papers of only average quality, nothing of very great importance having been brought before the institution. The Institution of Mechanical Engineers (Birmingham), the Institution of Engineers in Scotland, and the Scottish Shipbuilders' Association, have each had numerous papers, highly interesting and valuable contributions to practical science. Indeed, it has become a subject of ordinary conversation that there is a total want of that robust vitality in the London Institution of Civil Engineers which is found in the more northern Scientific Societies.

Another attempt is about to be made, by the Atlantic Telegraph Company, to connect Europe with North America, by a submarine telegraph cable, and it is to be hoped they will be more successful than on the previous occasion. The Indian Council have decided upon undertaking at a cost, it is said, of £300,000, the construction, and laying of a submarine cable across the Persian Gulf.

Beyond the International Exhibition, with its magnificent display of machinery—British and foreign, there is but little which calls for special mention here, as having occurred in connection with the various subjects of which our Journal treats. During the past year we have lost several engineers and men of science, whose deaths have been recorded in our pages. The various trials of the novel ordnance and projectiles, as also of the various contrivances for armour plating, or defensive coating for war-ships, have been noted. All that is novel in connection with the improvements in marine engines, and machinery for the war and mercantile marine, the various improvements in naval constructions and in steamship performance, have been given as fully as heretofore. The locomotive engine and railway machinery, and the various other improvements connected with the construction and working of railways, have received due attention; and generally the progress of mechanical science has been carefully recorded in our pages, and every branch of manufacturing and other industries have received their share of attention; in short The Artizan will be found to be a complete record of all that is valuable in connection with the useful arts and sciences.

It has been our constant aim to guard against the mistake commonly committed in class publications of advertising, under the cloak of a scientific notice, mere schemes, however worthless, and of bestowing praise and claiming merit for inventions indiscriminately, simply because they have been patented, or are illustrated pictorially. It is this practice, which, having been pursued by some of the class journals of this country, has lowered the estimation in which they were formerly held amongst scientific men, to the level of a mere advertising sheet. Our endeavour has been to exclude everything which will not bear the test of practical experience derived from past practice, and in making selections of subjects for illustration and for papers in our monthly issue, we have sought to give only such as would increase the stock of practical knowledge, and advance it a step further in the right direction—in this we have been aided by numerous friends and old contributors to the pages of The Artizan, and for which aid we are exceedingly grateful.

Notwithstanding the large number of copper-plate engravings and other illustrations which we have given during the past year, there are still several subjects which remain uncompleted for want of accurate details, or for some other equally good reason—but these will be published with all possible speed.

The practice which we introduced some time ago of using both sides of the folding and other sheets for illustrations, and which we have hitherto confined to outline sketches, composite plates, and transfers from wood and stone, we purpose in future to extend to the regular Artizan copper-plate engravings, by which means we hope to so increase the number of plates, as to still further enhance the value of The Artizan.

We have also made arrangements by which further improvements will, from time to time, be introduced in the body of the work during the current year, whereby additional value will be given to The Artizan as a standard work of reference.

We have also arranged that in future our country and foreign subscribers and others, connected with engineering, and other branches of mechanics and manufacturing operations, who may have occasion to visit London, shall have at the Publishing Office every facility afforded them, without expense, for obtaining whatever information, advice, or assistance they may stand in need. This has been strongly urged upon us by numerous subscribers and friends during their visit to the International Exhibition, and we readily adopt the suggestion, and invite those who wish to avail themselves of these facilities to do so whenever and as often as they please; and, having correspondents in every important city throughout Europe and America, in addition to our possessing a very extensive acquaintance amongst manufacturers and others, we believe that the suggestion which has been made to us, and which we are now prepared to act upon, will prove of considerable service to our country and foreign friends.

When we look back to the time of the first issue of The Artizan, and refer to the early volumes, when a portion of each number was devoted to the reports of the meetings of the "Artizan Club," and we cannot but observe the vigourously-healthy tone which then pervaded the work, and the true smack of sound practical knowledge and sterling common sense which cropped out everywhere, and showed The Artizan to be then in advance of the period and its contemporaries. The original and peculiar style adopted by the projectors of The Artizan Journal for conveying a vast deal of very valuable practical stuff to those whom they addressed, soon told upon the success of the Journal, which became well established amongst engineers and practical mechanics, both north and south of the Tweed, and from thence it became known, and its sphere of usefulness was extended throughout Europe and America, and the tide of its popularity has continued to flow onward, year by year, until we are able to say, with truth, what we believe cannot be said of any other monthly scientific Journal, that it is read and studied in every part of the world where English skill or enterprise has penetrated.

We look forward to an extension of the support which The Artizan has received, and we believe deservedly, during the last twenty years, and perhaps more especially during the last six or seven years; and we shall be pleased to receive from our friends as heretofore any suggestion with which they may favour us for the improvement of the Journal.

THE CONSTRUCTION, MANŒUVRING, AND PROPULSION OF SCREW STEAMERS.

(*Illustrated by Plates* 227 *and* 228.)

We published in our last issue, under the head of "Notes and Novelties," an account of the trial trip of the double screw steamer *Flora;* and, as the subject of the application of double screw propellers was very ably treated upon by Commander T. E. Symonds, R.N., in a paper read by him some few months ago, at a meeting of the United Service Institution, we give herewith two plates illustrative of some of the most important points in Captain Symonds's paper.

Plate 227 illustrates a series of views from a model of an armour plated light-draught coast defence ship of about 2300 tons; length, 240ft. breadth, 45ft.; draught, 15ft.; mounting 14 guns, 8ft. 6in. above the water; jointly designed by Commander Symonds and Mr. R. Roberts, C.E., to meet conditions suggested by Rear Admiral George Elliot, and submitted by him last year to the Admiralty and War Office.

Fig. 1 is a general exterior view showing a proposed method of protecting the guns by inclined armour-plated sides, rounded from the deck upwards, terminating in a rounded platform or deck; the top sides forward and aft being fitted to lower when bow or stern guns are used.

Fig. 2. Deck plan, showing a method of giving ventilation and light, and relieving the gun-deck from smoke by a strong iron grating, R, in which are hatchways for giving access to the deck, for boarding or repelling boarders. R R are other hatchways, similarly fitted for ventilation and access to other parts of the ship.

Fig. 3. Longitudinal section, showing internal arrangements. T. Bread and dry provision room. K. Engine room. E. Athwart ship coal bunkers. N. High-pressure cylindrical boiler, with method of fitting the uptake to funnel, and the cellular casing round the funnel to give ventilation in the boiler room, the same arrangement being provided round the masts to ventilate between decks. The funnel is telescopic; when run down projects only three feet above the deck in action, the draught being given by the apparatus referred to above. U. The magazine. V. Chain locker. W. Windlass. X. Form of stem for receiving the prow of ram, and method of strengthening the bows to resist the shock, being a series of short decks or breast hooks.

Fig. 4. Floor plan, showing arrangement of longitudinal bulkheads, forming cellular girders, with the side applied as coal bunkers, water tanks, and other purposes.

Fig. 5. Stern view, showing propellers, and three stern chase guns, with gunwale lowered on starboard side.

Fig. 6. Section in engine room, showing proposed arrangement of engines, K; coal bunker, E; with cellular bottom and keels, C, D.

This vessel is intended for the defence of harbours, or to cross the Channel if required, being quite capable of taking the sea, and may be rigged either as a schooner or polacca. She is fitted to act as a ram, and, from her great longitudinal strength, imparted by the cellular mode of construction adopted, should, we conceive, be specially adapted for that purpose, as also from the fact of the two screws giving her the power of turning in her own length, and, being steered by them, going ahead or astern without assistance from the rudders; in fact, under steam the rudders are unnecessary.

It will be seen on reference to Plate 227, that it is proposed to use a form of high pressure boiler and method of connecting with the uptake, well calculated to overcome the very serious drawbacks attendant upon the existing boiler arrangements of our war steamers and gunboats, more specially,—some ofwhich have two sets of low-pressure boilers, one reaching nearly to thedeck for ordinary purposes, styled "working boilers," which, being exposed toshot, cannot and are not intended to be used in action. The other set, placed lower, but occupying greate rfore and aft space, are called "fighting boilers."

The arrangement for the "uptake" of the furnaces allows one boiler to be cut off without interruption to the remainder; the cellular casing around the funnel will ventilate and lower the temperature of the boiler-room besides giving additional support and protection to the funnel; and instead of the stokers being between two long rows of furnaces, they stoke from opposite sides, which must necessarily improve their condition.

The coal bunkers, E, on either side the boiler and engine-rooms, and athwart ships will add to the security of both, defending them from any shot that may either penetrate the armour plating or strike below it.

The plan of fitting the coal bunkers forms an important feature in the cellular system, and adds materially to the longitudinal strength, so specially requisite in light-draught ships, in which "the beam" is of decreased depth.

The coal bunkers in large ships may be filled expeditiously by means of small carriages running on a tramway, the cells being made to communicate with one another, so that the coals can be readily removed if required.

In this cellular arrangement much coal trimming will be dispensed with, as coal may be taken from any required cell of the bunker without the remainder shifting.

It is proposed to arm this vessel with 14 guns, two of which are to be of very heavy calibre, one forward and the other aft, being bow and stern chasers, firing in a line with the keel side guns, by shifting them, there being spare ports for the purpose. Thus, three guns can be brought into action, whether chasing or retiring, and six on each broadside.

This plan of defending the guns, in addition to the advantage of having a battery of three guns forward and aft, will reduce the weight of hull and armour-plates.

Plate 228 illustrates the model of a larger passenger or troop-ship, constructed upon the proposed plan of Mr. Roberts and Captain Symonds.

Fig. 1. Being a plan taken through the engine-room.

Fig. 2. Deck plan, with arrangement of cabins, stalls, and saloons.

Fig. 3. Is a longitudinal section showing the arrangement of cellular girders formed by cabins, stalls, keels, &c.

Fig. 4. Stern view, showing non-fouling propellers and rudders.

Fig. 5. Transverse section showing stalls.

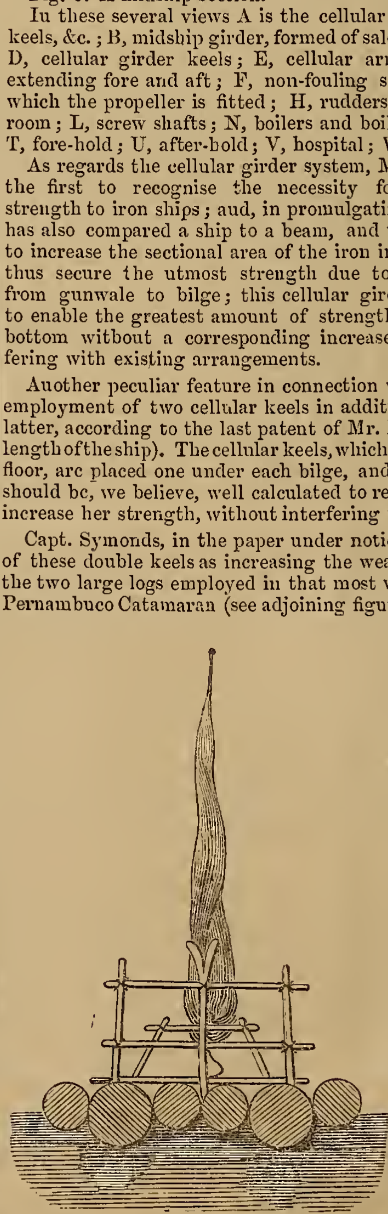
Fig. 6. A midship section.

In these several views A is the cellular girder, formed of cabins, stalls, keels, &c.; B, midship girder, formed of saloons or stalls; C, cellular bottom; D, cellular girder keels; E, cellular arrangement of coal bunkers, &c., extending fore and aft; F, non-fouling screw propeller; G, the trunk to which the propeller is fitted; H, rudders, or steering-blades; K, engine-room; L, screw shafts; N, boilers and boiler-room; O, funnel with casing; T, fore-hold; U, after-hold; V, hospital; W, officers' mess-room.

As regards the cellular girder system, Mr. Roberts appears to have been the first to recognise the necessity for giving greater longitudinal strength to iron ships; and, in promulgating the principle of his patent, he has also compared a ship to a beam, and that, as a beam, it was desirable to increase the sectional area of the iron in the upper part of the hull, and thus secure the utmost strength due to whole depth of the ship's side from gunwale to bilge; this cellular girder system being so arranged as to enable the greatest amount of strength to be obtained at the top and bottom without a corresponding increase of weight, and without interfering with existing arrangements.

Another peculiar feature in connection with Mr. Roberts' plan, is the employment of two cellular keels in addition to the cellular bottom (which latter, according to the last patent of Mr. Roberts', is continued the whole length of the ship). The cellular keels, which extend nearly the whole length of floor, are placed one under each bilge, and are in part cellular girders, and should be, we believe, well calculated to resist the rolling of the vessel and increase her strength, without interfering with the steering.

Capt. Symonds, in the paper under notice, very aptly compared the use of these double keels as increasing the weatherly qualities of a vessel, to the two large logs employed in that most weatherly of all craft afloat, the Pernambuco Catamaran (see adjoining figure).



We agree with Capt. Symonds that a light draught ship, whether for war or mercantile purposes, must possess decided advantages over those of heavy draught on numerous occasions, and especially when intended to operate inshore, when they may then evade them by crossing shoals or bars and take shelter under batteries (and attack them).

The next important feature in connection with the subject of Captain Symond's paper, is the application of double screw propellers. It is well known that good results have in many instances been obtained from vessels fitted with two screws, even with the existing form of after sections. Now, Capt. Symonds in conjunction with Mr. Roberts, proposes to apply the screws in such a manner as to overcome the greatest objections which are advanced against the application of double screws, viz., that the present

form of after section with the dead wood intervening, does not admit of sufficient diameter, and offers a great obstruction to propulsion and steerage; and, that the speed at which it would be necessary to drive screws of finer pitch would be too high.

The plan, as described by Captain Symonds, is as follows (and will be better understood on reference to our plates 227 and 228):—

It is proposed to use a propeller F, which, by its form alone, is calculated to reject or throw off all impediments, and if striking a hard surface will not receive any serious injury.

The vanes or blades are of wrought iron or steel secured to spiral flanges on the boss, the flanges being covered by a cycloidal casing of wrought iron; the root of the blades being long, and therefore well supported, admits of their being made thinner than those of the ordinary shape in cast metal; being thinner, they displace less water, and consequently absorb less power in turning; being of wrought iron, they are far less liable to injury, and can be readily replaced or repaired when damaged. They may be estimated at about half the weight, and one-third or one-fourth the cost of those made of gun-metal of the same diameter.

These blades are tapered on both the leading and after edges, and when in rotation, whether turning ahead or astern, may be said to form a cone that will throw off any passing wreck, chain, or cordage, without fouling or injury; a coil of rope falling upon this screw would be, it is anticipated, instantly thrown off. This form of blade will also insure a more constant and equable action on the water under all circumstances, and thereby reduce vibration.

The method of attaching the screw shaft enables it to be readily shipped and unshipped, and, being comparatively light, the after bearing is dispensed with, part of the after length of the screw shaft into which the short shaft of the propeller is shipped being of increased diameter, so as to give a sufficient bearing to prevent the weight of the screw wearing unduly, and to admit of being bored out to receive the short shaft attached to the propeller, which is secured by a key, gib, and cotters; by this means the screw and short shaft may be removed without disturbing the main shaft or admitting water into the ship.

There being no aperture for the screw, the section of the ship will be stronger and lighter. The screws are fitted to cylindrical trunks, G, fig. 3, under either quarter, which connect the keels with the counter of the ship; these trunks are the same diameter as the boss of the screws, against which they fit closely, so as to prevent anything getting between them. The rudders, H, being attached to the after extremity of the keels, but before and lower than the screws, so that both screws and rudders are quite clear of each other, and are thus capable of performing their respective functions without hindrance, both being immersed at such a depth as to place them entirely out of reach of shot or ram, and prevent their being lifted out of water. Captain Symonds argues that by this method of fitting the screws, the water being already displaced by the ship and trunks, it comes direct to the screw-blade and closes by its own gravity on the cycloidal boss, leaving an appreciable vacuum, whereas in the ordinary mode, the boss not only displaces a large volume of water, but leaves a considerable vacuum in its wake, which will absorb power, retard speed, and, it is believed, cause vibration.

By reversing either screw, the ship may be turned rapidly by the screws alone, to starboard or port in her own length (as with two sculls in a boat, one backing and the other pulling), and may be steered, going ahead or astern, by these screws, without any assistance from the helm, in the most accurate manner.

The rudders are geared together, and worked by steam or by a wheel on deck, or in the after part of the engine-room, so that in action the engineers and helmsmen receive orders simultaneously, helm and screws acting together on the instant, helmsmen and steering apparatus being out of reach of shot.

It will be seen on reference to our Plates that as the screws will be driven at a higher speed than a single screw of large diameter, it is proposed to use gearing; although if considered preferable, direct action may be used, as being equally applicable. Each of the screw shafts is shown as being driven by two horizontal high pressure engines K, with surface condensers P and multitubular cylindrical boilers N, the whole of which, including the gearing, will be considerably lower than those in use at present. The substitution of far smaller engines in lieu of the large engines now in use would be attended with especial advantage, as the liability to accident must be very considerably reduced, the engines may be more readily replaced or repaired, are less costly, and duplicate parts may also be carried with facility.

We must not conclude this subject without referring to an additional and very important feature dwelt upon by Captain Symonds, viz., the necessity for labour-saving machinery; and we quite agree with him in arguing the great necessity which exists for the more extended adoption of simple mechanical contrivances for saving labour on board ship.

We may add that the models forming the subjects of our plates were exhibited in the Naval Department of the late International Exhibition.

A CRITICAL AND HISTORICAL REVIEW OF LOCOMOTIVE ENGINEERING.

(*Continued from page* 272.)

(*Illustrated by Plate* 229.)

Having analysed the nature and inquired into the magnitude of the various resistances which the engine has to overcome, if we assume the amounts as defined by the several formulæ which we have laid before our readers to be sufficiently accurate for all practical purposes, nothing could be easier now than to define the power which is developed by an engine while it is performing a certain duty. Let us suppose, as a first example, that it is desired to run a train of 100 tons (engine and tender included) up an incline of 1 in 70, at a speed of 40 miles per hour; taking Dr. Rankine's formula as the one nearest the truth, and admitting the resistance due to back pressure to be 27 per cent. of all other resistances, the total resistance at the circumference of the driving wheels will be

$$R\,t = 100\,(1 + 0{\cdot}27)\left(8 + \frac{40^2}{180} + 2240 \times \frac{4}{3} \times \frac{1}{70}\right) = 7561 \text{ lbs.}$$

and the work performed expressed in mechanical horse ... 1

$$HP = \frac{7561 \times 5280 \times 40}{60 \times 33{,}000} = 806 \text{ horse}$$

Or, as a second example, let it be proposed to run a train up an incline of 1 in 70, with a load of 112 tons (engine and tender included), at a speed of 20 miles per hour, taking the back pressure at 22 per cent. of all other resistances, the total resistance at the circumference of the driving wheel will be

$$R\,t = 112\,(1 \times 0{\cdot}22)\left(8 + \frac{20^2}{180} + 2240 \cdot \frac{4}{3}\ \frac{1}{70}\right) = 9190 \text{ lbs.}$$

and the power in horse developed ... 2

$$HP = \frac{9190 \times 5280 \times 20}{60 \times 33{,}000} = 490 \text{ horse}$$

Upon the mode of arriving at this expression of power in horse or in units of mechanical work, all engineers and all writers on the subject are well agreed, however much they may differ as to the amounts either in detail or in the aggregate; and here, perhaps, will be the proper place to take note generally of Mr. Dixon's remarks on the capabilities of locomotive engines. In his late pamphlet on train resistances, Mr. Dixon finds fault with Mr. Fairbairn for stating in his *Useful Information for Engineers* that the duty performed by one of our largest locomotives, travelling at 45 miles per hour, would exceed 700 horses, and seems to think that no engine had ever, or would ever, perform a duty exceeding 350 horse-power; yet do we find by the foregoing examples, which are by no means exaggerated, that in the first case the engine would perform a duty of 590 horses, and in the second case a duty of 400 horses, deduction being made in both cases for the loss of power by back pressure; and in Clarke's record of Gooch's experiments on the engine "Great Britain" we find that on one occasion, travelling at a speed of 57 miles per hour, it performed an effective duty of 713 horses; and on another occasion, travelling at a speed of 54 miles per hour, an effective duty of 763 horses, the power exerted being measured in both cases from the steam diagram; these several cases, therefore, plainly show that Mr. Fairbairn has by no means overrated the capabilities of the class of engines he referred to, but has simply endorsed a fact recognised by previous writers.

From a careful inquiry we find that, at a very early period in the history of locomotive engineering, those engaged in its pursuit were fully aware of the fact that the seat of power of the engine is in the boiler; for we find in that 1836 Pambour, in his expression of the power of engines, introduces their evaporating capabilities as one of the chief elements of his formula; that in 1846 Brunel, in his evidence before the Gauge Commissioners, says as follows:—"In speaking of powerful engines, I refer to engines of great capacity of steam.' That Stephenson says:—"The size of the boiler is the only limit to locomotive power," while the adoption of the tubular boiler and the blast pipe in the elder Stephenson's memorable "Rocket," at the early date of 1829, was unquestionably the result of a conviction that heating surface and rapid combustion are the great means of developing power." It was not, however, until Pambour had made his experiments and published his work that engineers became possessed of a tolerably accurate knowledge either of the power required for the performance of a certain duty upon the permanent road, or of the capabilities of the boiler; indeed, this want of knowledge seems to be plainly evidenced by the slow progress made in the development of the boiler previous to that date, and by the sudden development which followed soon afterwards; thus we find that the heating surface of the "Arrow," built in 1830, amounted to 303 square feet, and that that of the "Goliath," built in 1836, amounted to 360 square feet only, though it was the largest of the

engines then at the disposal of Pambour; while Brunel, who at the very outset of his career as a railway engineer, in 1833, showed a spirit of adventure of incredible boldness, built the "Ajax" in 1836-7, with 10-feet driving wheels, yet with only 474 square feet of heating surface. In 1838, however, (that is just at the time when those interested in the question must have become acquainted with Pambour's writings,) we find that Brunel designed the "North Star,'; with a heating surface of 706 square feet; and that from that time he kept increasing it in the engines of the Great Western Railway until, in 1846, it reached the almost impracticable amount of 1952 square feet in the "Great Britain." As we find no record of any equally sudden and marked development of the boiler in the engines upon other lines, we feel in justice bound to ascribe to Brunel the merit of having first carried into practice the results of scientific observation, and made the locomotive engine that powerful agent of the purposes of man which we know it to be now; for, indeed, upon the narrow gauge, the first great step in this direction was only made in 1843, when Stephenson patented his long boiler engine.

When Pambour made his experiments, he found that the amount of water evaporated per square foot of heating surface per hour, was about 0·2 cubic feet; this, however, includes the water which is carried along in a globular state with the steam, and which, having no elastic force, is literally wasted; the loss by priming was by him ascertained, by calculation of the work performed, to be about 25 per cent. of the whole amount of water consumed, so that finally the square foot of heating surface had an evaporating capability of 0·15 cubic feet of water only, and the coke required was from $9\frac{1}{6}$ to $11\frac{3}{5}$ pounds per cubic foot of water, or the amount evaporated per pound of coke from $5\frac{1}{3}$ to $6\frac{2}{5}$ pounds. Pambour also inferred from his experiments that the best proportion between firebox area and tube area, in regard to economy of fuel is as 1 to 10.

In the rate of *apparent* evaporation per square foot of heating surface it does not appear that we obtain any greater results now than were obtained 26 years ago, for the experiments recorded by Clark, made on various classes of engines, and which we reproduce in the subjoined table show a maximum evaporation of 0·2 cubic feet only.

Engine.	Ratio of Heating Surface to Grate Area.	Water evaporated per sq. ft. of heating sur.	Water evaporated per lb. of Coke.
		Cubic Feet.	lbs.
Orion	52	0·12	9
Cal. Railway Pass. Engine	66	0·13	9·1
Snake (Gooch's)	72	0·17	8·9
Sphynx (Sharp's)	90	0·20	8·92

These are the mean results of a good number of experiments, and on that account may be considered tolerably trustworthy; from them Clark very naturally inferred that the rate of evaporation increases with the ratio of heating surface to grate area, and on this assumption has constructed the following formula, defining the amount of water evaporated in cubic feet per square foot of heating surface per hour:

$$n\ 0{\cdot}00222\ \frac{A}{a}$$

where A and a respectively represent the heating surface and the grate area. From observations made upon some passenger engines on the Great Eastern Railway, supplied to us by Mr. Sinclair, we gather that with a ratio of heating surface to grate area of 71 to 1, the rate of evaporation is only 0·12 cubic feet, and as these observations are taken from the engines performing their regular work, perhaps they are a more faithful representation of the actual state of things, than observations made with the preconceived ntention of being noted down, when everything is put into the best possible working condition; at the same time it should be mentioned that this result was obtained by engines burning coal instead of coke, and if the tubes had not been newly cleaned, the probability is that they would be covered with a coating of soot, a highly non-conducting substance, which contingency may in some measure account for the somewhat low figure mentioned.

These several results compared with those obtained by Pambour show a rate of evaporation per square feet of heating surface, rather less in modern boilers than the earliest ones; nor are we astonished that such is the case, for, while we have more than trebled the amount of tube surface, the size of the boiler barrel being necessarily limited by the conditions of the gauge, we have at the same time so choked it up, as to greatly hinder the formation, or, at any rate, the liberation of the steam. This fact has not long remained unobserved, for we find that at an early date some engineers have endeavoured to obviate it as much as possible, by increasing the heating surface in the fire box by means of the midfeather, rather than in the tubes; this, we believe, was first done in 1847, by Sharp, in the *Spyhnx* (Fig. 1), and in the *Jenny Sharp* (Fig. 2), and by J. V. Gooch, in the *Snake* (Fig. 3); the *Sphynx*, in particular, has very few tubes, with large water spaces, and to this we feel inclined to ascribe in a great measure the high rate of evaporation of 0·2 cubic feet. With a view to the same object Mr. Fernie of the Midland Railway (see Fig. 4), in his patent boiler, arranges the tubes in vertical instead of horizontal rows, and thus obtains an unbroken vertical water space, through which the steam liberates itself without impediment; this arrangement has been attended with very good results, and as the same number of tubes can be put into the same space as by the old method we can see no reasonable objection to its general adoption.

Reverting to our comparison of modern with Pambour's results, we find a great improvement as regards the loss of water from priming, and in the consumption of fuel; it is true that the experiments recorded by Clark, show a loss by priming and condensation varying from 3 per cent. to 32 per cent., but from a series of 15 experiments on various classes of engines and under various circumstances we find the mean loss to be 18 per cent. only of the total amount of water consumed which, we think, may be taken as a fair average, and which shows a gain of 28 per cent. on the loss sustained in the days of Pambour; on the subject of consumption of fuel, we find also that one pound of coke evaporates now from 8 to 9 pounds of water, showing a gain of 30 per cent, on the results obtained by Pambour, and thus we see that the gain in consumption of fuel is equal to the gain effected on the loss from priming; the one fact, indeed, is a natural sequeuce of the other, but their concurreuce deserves to be pointed out here because it tends to testify to the correctness of the observations recorded by Pambour on the one hand, and by Clark on the other. So far we have not taken into consideration the important item of pressure, but in order to draw an accurate parallel between these several results we should compare the pressures to which the steam in each case had been raised, and see what is the relative quantity of heat required for steam at various pressures. It had been admitted by Pambour that the quantity of heat contained in steam is constant for all pressures, and if such were the case, the question would require no further investigation, since this would imply that it takes no more coal to convert a pound of water into steam of 50lbs., than to conver it into steam of 150lbs. pressure. Regnault's experiments, however, have proved that this assumption is not quite correct, but that there is a slight increase of total heat with the increase of pressure, and for the satisfaction of our readers, we subjoin an abridged table of pressures, temperature and total heat of steam as translated from Regnault's tables.

Pressure.	Temperature.	Total Heat.	Pressure.	Temperature.	Total Heat.
lbs.	Deg.	Units.	lbs.	Deg.	Units.
15	213	1147	90	320	1179
30	250	1159	105	331	1182·6
45	274	1164	120	341	1185·3
60	292	1170	135	350	1187·6
75	307	1174·4	150	358	1190

From a perusal of these figures which show such a trifling increase of total heat that in practice it cannot possibly be felt, we are compelled to conclude that Pambour's assumption remains practically correct and consequently that, although modern engines are worked at nearly treble the pressure at which they were worked in his days, yet does the steam as now used not necessarily require a greater amount of fuel. It follows, also, from the preceding remarks, that an engine becomes more economical in proportion as the boiler is made to generate steam at a higher pressure.

We have learned in the first portion of this paper how to express in units of mechanical work the power developed by an engine in the performance of a certain duty, and we have now seen what are the steam generating capabilities of the boiler, along with the loss of power sustained from priming and condensation; provided, therefore, we can ascertain what volume of steam is required for each horse-power developed, it will be a simple matter to design a boiler capable of producing a given required power. This at any rate seems to be the most natural, and is, perhaps, the simplest mode of procedure; but when we remember that steam may be worked with or without expansion, and that an engine may be made to run at slower or higher speeds, the question naturally presents itself: under which of these conditions does the engine yield its maximum power? For it is evident that the problem should be made subject to this condition, since the engine can be made to yield any power inferior to its maximum. In

order to solve this question, Pambour first finds the expression of power at *any* speed with *any* pressure, and finding that in his formula, obtained from purely theoretical considerations, the factor *speed* appears only as a negative term, he naturally infers that the engine yields its maximum power at the lowest possible speed for a given pressure; and, as the total pressure could never be less than the resistance to be overcome, the condition of the maximum will be realised when the pressure upon the piston, reduced to its value at the circumference of the driving wheel, is equal to the resistance to be overcome, for, if it were greater, the surplus pressure would act as an accelerating force, and the condition of minimum speed would at once be destroyed. When, therefore, the data of the maximum duty are given, and the resistance at the driving wheel ascertained, as in the case of formulæ 1 and 2, nothing could be simpler than to define the *mean actual pressure* upon the piston, and, this being done, the following mode of procedure will lead us to the proportions of the boiler. The speed of the piston is evidently regulated by the volume of steam which has to pass through the cylinders; and, if S be the number of cubic feet of water evaporated per hour, and μ the relative volume of the steam at the mean *absolute* pressure at which the work has to be performed (that is, the mean actual pressure, augmented by 15 pounds, for atmospheric pressure), the volume of steam to be sent through the cylinders in one hour will be μ S; on the other hand, the capacity of the cylinder, including clearance and steam ways, which we will take at $\frac{1}{25}$ the value of the stroke, is $\frac{1}{4}\pi d^2 \, 1{\cdot}04\, l$, d and l being respectively the diameter of the cylinder and the stroke, both expressed in feet; and as there are 4 cylinders full of steam to be discharged for every revolution of the driving wheel, the number of revolutions per hour will be

$$\frac{\mu S}{1{\cdot}04\,\pi\, d^2 l}$$

and the speed of the engine in miles per hour

$$v = \frac{\pi D}{5280} \cdot \frac{\mu S}{1{\cdot}04 \, . \, \pi \, d^2 l} = \frac{D}{d^2 l} \cdot \frac{\mu S}{5491} \quad \ldots\ldots\ldots\ldots (3)$$

where D stands for the diameter of the driving wheel in feet, and v for the speed in miles per hour; from this equation we find for the volume of water required per hour for a given speed

$$S = v\,\frac{5491}{\mu} \cdot \frac{d^2 l}{D} \quad \ldots\ldots\ldots\ldots (4)$$

Such would be the expression of S at any rate, if we did not work the steam expansively; but, as in modern engines, the greatest admission possible is 0·75 of the stroke, and as the relative duty of steam at this rate of expansion is 1·28, we must correct formula (4) by dividing by 1·28, in order to obtain the correct value of S, which becomes

$$S = v \, . \, \frac{5491}{1{\cdot}28\,\mu} \cdot \frac{d^2 l}{D} \quad \ldots\ldots\ldots\ldots (5)$$

And, as we know that every square foot of heating surface can evaporate 0·16 cubic feet of water per hour, deduction being made for the loss of priming and condensation, if A be the heating surface of the boiler in square feet, we shall have

$$0{\cdot}16\,A = S = v \, . \, \frac{5491}{1{\cdot}28\,\mu} \cdot \frac{d^2 l}{D}$$

and, finally,

$$A = \frac{S}{0{\cdot}16} = v \, . \, \frac{34318}{1{\cdot}28\,\mu} \cdot \frac{d^2 l}{D} \quad \ldots\ldots\ldots\ldots (6)$$

remembering always that μ is the relative volume of the steam at the mean absolute pressure at which the engine will have to work. It will be perceived that this is not an empirical formula, but one arrived at by theoretical considerations of unquestionable correctness; the factor μ is the only one obtained by means of an empirical formula, but the accuracy of the tables of relative volume of steam, as corrected by the experiments of Regnault, Rankine, or Fairbairn, cannot be doubted, at any rate to any practically appreciable degree, and, as regards the co-efficient of evaporation, that is obtained from experimental evidence. As an instance, let it be proposed to construct an engine capable of performing the maximum duty embodied in formula (2), with a cylinder 16in. diameter and 22in. stroke; the total resistance at the circumference of the driving wheel was found to be 9190lbs., back pressure included, and, therefore, the mean actual pressure p_1 upon the square inch will be

$$p_1 = \frac{9190 \times 5{\cdot}5 \times \pi}{0{\cdot}785 \times 16^2 \times 4 \times 1{\cdot}83} = 108\text{ lbs.}$$

the diameter of the driving wheel being taken at 5ft. 6in., and the mean absolute pressure will be 108 + 15 = 123lbs.; the relative volume of steam at this pressure is 213, by the old tables, and the heating surface required will be

$$A = \frac{34318}{1{\cdot}28 \times 213} \times \frac{1{\cdot}33^2 \times 1{\cdot}83}{5{\cdot}5} \times 20 = 1300\text{ sq. feet.}$$

It should be remarked here that this mode of procedure is applicable to passenger as well as to goods' engines, for since the case of maximum power is that of minimum speed; conversely also is the case of minimum speed that of maximum power, and, consequently, if an engine be proportioned to yield its maximum power at a given minimum speed, it may be made to work at any higher speed which is practically attainable; for instance, if we would proportion an engine capable of performing the maximum duty embodied in formula (1), with a cylinder 17in. diameter and 22in. stroke, at the minimum speed of 40 miles per hour, the total resistance at the circumference of the driving wheel having been found to be 7561lbs., back pressure included, the mean actual pressure per square inch on the piston will be, with 8ft. driving wheel,

$$\frac{7561 \times 8 \times \pi}{0{\cdot}758 \times 17^2 \times 4 \times 1{\cdot}83} = 115\text{ lbs.}$$

and the absolute pressure 115 + 15 = 130lbs.; the relative volume of steam at this pressure is 231, and as the engine at this speed would be worked with an admission of 0·50 of the stroke, at which degree of expansion the relative efficiency of steam is 1·69, we should find the heating surface required to be

$$A = 40 \times \frac{1{\cdot}69 \times 231}{34318} \times \frac{\overline{1{\cdot}417}^2 \times 1{\cdot}83}{8} = 1605\text{ sq. ft.} \ldots\ldots (7)$$

Sewell, in his edition of Tredgold, has constructed an empirical formula to define the horse power of a locomotive boiler in terms of the heating surface exclusively, from which, of course, the heating surface may be calculated when the horse power to be developed is given; his formula stands thus:—

$$HP = 3\sqrt{\left(\tfrac{1}{2}\,a + t\right)\left(\tfrac{1}{2}\,\frac{A_1}{9}\right)}$$

where a represents the area of the vertical sides of the fire box, t the area of the top, and A_1 the area of the tubes. Now the top of the fire box is generally about $\frac{1}{4}$ the area of the sides, we may, therefore, put $\frac{1}{2}\,a + t = \frac{3}{4}\,a$, and again the area of the sides is generally about $\frac{1}{12}$th that of the tubes, so that finally we may put $\frac{3}{4}\,a + t = \frac{3}{4}\,a = \frac{1}{16}A_1$; Sewell's formula may, therefore, be put into this shape:

$$HP = 3\sqrt{\frac{1}{16}\,A_1 \times \frac{1}{18}\,A_1} = \frac{3}{17}\,A_1$$

whence,

$$A_1 = \frac{17}{3} \, . \, HP.$$

but as the fire box area is to be $\frac{1}{10}$ that of the tubes, if A again be made to represent the total heating surface we shall have

$$A = \frac{11}{10}\,A_1$$

and finally

$$A = \frac{18{\cdot}7}{3}\text{ H. P.} = 6{\cdot}23\text{ HP}$$

If this formula be applied to the case previously instanced where the maximum power, exclusive of back pressure, was to be 400 horse, we shall find

$$A = 6{\cdot}23 \times 400 = 2490\text{ sq. feet.}$$

This figure, we think, is sufficient in itself to condemn Sewell's formula at once, for there has never yet been a locomotive boiler made with a heating surface much exceeding 2000 square feet, and we have seen in the case of the *Great Britain*, that engines of this class yield an effective power of upwards of 750 horses.

Clark defines the horse power of the engine in terms of the grate area, and obtains the heating surface by laying down the rule that it should be equal to 80 times the former; his mode of procedure is as follows: he first ascertains the amount of water, in pounds, required per effective horse power per hour, and from Gooch's experiments on the *Great Britain*, makes it to be,

$$\text{lbs. water per effective horse per hour} = 22 \, . \, e + 11$$

where e is the period of admission in percentage of the stroke. This formula which tells us that 11lbs. of water are lost by back pressure, priming and condensation, and clearance for all grades of expansion is based upon three mean results of nine experiments, a very slender foundation indeed, it must be owned, for a formula of so much importance; but, as we have the means to test its accuracy, it will be well to do so: since the loss by back pressure is laid down at about 21 per cent. of the whole, and the loss by priming, condensation and clearance at 18 + 4 = 22 per

cent., the total loss of water amounts to 46 per cent., and we should, therefore, have the following proportion,

$$100 : 22 . e + 14 :: 46 : 14$$

which calculated for the maximum admission of 75 per cent. of the stroke stands thus:

$$100 : 30{\cdot}5 :: 46 : 14$$

or,

$$1400 = 1403$$

The formula, therefore, may be said to be practically correct for the case of maximum admission, so far at any rate as regards the ratio of total expenditure to loss; but if it is calculated for any other period of admission, the above proportion must become an impossibility, for since the total percentage of loss remains very nearly constant, three of its terms will remain unaltered, while one of them changes, when the proportion necessarily ceases to be true, in the case of an admission of 40 per cent. for instance, it will stand thus:

$$100 : 23 :: 46 : 14$$

or,

$$1400 = 1058$$

which is an absurdity.

From the above consideration we are forcibly led to the conclusion that there is no such thing as a constant loss of 14 pounds of water per horse per hour for all grades of admission, but that this loss must vary in the same ratio as the total consumption, provided the per centage of total loss of power remains constant; but if it be satisfactorily proved that this latter loss varies in a certain ratio, the loss of water must vary at the same time, also inversely in the latter ratio.

We have found, however, that the formula works well in the case of maximum admission, which is also the case of maximum power, if, therefore, we assume it to be correct in its amounts and proceed according to Clark's method, we shall find the amount of coke consumed per horse per hour by dividing by 8, thus:

$$\text{lbs. coke per horse per hour} = \frac{22 \times 0{\cdot}75 + 14}{8} = 3{\cdot}81\text{lbs.}$$

and for a given number of effective horse-power,

$$\text{coke in lbs.} = 3{\cdot}81 \text{ HP.}$$

Now it is found that one square foot of grate area can burn a maximum of about 100lbs. of coke per hour, and consequently we shall find the grate area, if we divide the above result by 100, thus:—

$$\text{grate area in square feet} = 0{\cdot}0381 \text{ H. P.}$$

but as the heating surface is to be 80 times the grate area, if we call it A again we shall have finally:—

$$A = 80 \times 0{\cdot}0381 \text{ HP.} = 3{\cdot}05 \text{ HP.} \quad \ldots\ldots\ldots\ldots\ldots \quad (8)$$

This formula calculated for the case selected to illustrate Pambour's method where the maximum power was to be 400 effective horse gives a heating surface,

$$A = 3{\cdot}05 \times 400 = 1220 \text{ sq. feet.}$$

a result which is only very slightly inferior to that found with Pambour's method, and from their comparison we have a right to infer that Clark's formula is correct also in its amounts, for the case of maximum power, but as it is altogether empirical, while Pambour's is theoretically correct, we should decidedly prefer the latter.

The several results which we have laid before our readers, have been obtained with the consumption of coke, and formulæ 6, 7, and 8, are constructed under the hypothesis that this will be the fuel used, but of late years great efforts have been made to substitute the much cheaper material coal for coke, the price of the former being rather less than one-half the latter, and since at the present date coal has found its way into almost exclusive use, it behoves us to see whether with this change of fuel, any of the primary data upon which these formulæ are based have also altered, to see in fact whether as much heat can be developed in a given time by the combustion of coal as by that of coke, and whether the unit of heating surface remains as effective as before. With this object in view, we ought perhaps, to refer to the chemical composition of coke and coal, but without entering into minutiæ which would not tend to the furtherance of our present object it will be sufficient to state that coke which is composed of solid carbon with a small per centage of ashes can develope on an average 12,500 units of heat, and that coal which is composed of about 60 per cent. of solid carbon with 25 per cent. of carburetted hydrogen can develope an equal amount of heat, and according to some French authorities may even develope more; theoretically, therefore, a pound of coal should evaporate as much water as a pound of coke, and this very nearly does take place in well managed stationary and marine boilers. Clark, however, states that in the locomotive boiler, he has found coal to be capable of rendering a duty of two-thirds that of coke only; and the result of actual practice on the London and North Western Railway as reported to us by Mr. Ramsbottom, confirms Mr. Clark's observations; there is, therefore, in the combustion of coal a loss of one-third, which must be accounted for, first by the imperfect combustion of portions of the solid coal which drop through the fire bars, and by the imperfect combustion of the volatile hydro-carbons which escape through the chimney in the shape of smoke; these are the two most palpable causes, but in our opinion, as already mentioned, the deposit of soot in the tubes, rendering them less capable of conveying the heat to the water, is a no less active cause of the loss stated; this latter view of the subject, so far as we are aware, has not before been propounded, and though practically it may be of little importance to know where the greatest amount of the loss is sustained, yet as an abstract question it is of sufficient interest to deserve special investigation.

The adoption of coal as the staple fuel for locomotive purposes is, however, of such recent date that engineers have not reached the point, and probably will not soon reach it, when they may turn their attention to the question of loss of heat and loss of evaporating power, their only endeavours having been, until now, to devise means for the prevention of smoke, in order to meet the requirements of the Act of Parliament, which forbids, not the coal, but the chimney to emit smoke; and were we to detail before our readers the many schemes that have been patented and tried with a view to the solution of this important problem, their number truly would be found to be *legion;* although, theoretically, the question is as simple as possible, since the only thing required is to supply those volatile hydro-carbons with a sufficient quantity of atmospheric air at a point just above the first source of heat, where the temperature is sufficiently elevated to enable carbon and hydrogen to disunite and to combine with the oxygen of the fresh air. Practically, however, the problem is fraught with several great difficulties not easily to be overcome; it is difficult, in the first place, to supply the air just at that point over the surface of the fire where the temperature will allow those chemical changes to take place; it is still more difficult to supply the air in such a manner as to mix it so perfectly with the gases of combustion that each particle will have a chance of meeting with the necessary equivalent of oxygen; and although the various schemes that have been tried have not all aimed at these two objects directly, yet has their number been proportionate only, we think, to the difficulty of the problem. We shall lay before our readers a few only of them, with a view especially to illustrate the fact that truth is often looked for in far-fetched, difficult, and expensive schemes, while afterwards it is more closely approached by contrivances of the greatest possible simplicity.

As early as 1837 we find that attempts at constructing coal-burning locomotive boilers were made by Messrs. Gray and Chanter, of the Liverpool and Manchester Railway; but, confining ourselves to more recent practice, we meet first with Mr. M'Connell's boiler (fig. 5), patented in 1852, in which the prevention of smoke was aimed at first by providing a large grate area, in order to obtain a liberal supply of air from underneath; secondly, by prolonging the fire-box a considerable distance into the boiler barrel, in order to give the gases of combustion as long a run as possible previous to entering the tubes, while it was sought also to facilitate their oxidation by means of a limited supply of air admitted through apertures in the fire-hole door; and, thirdly, by dividing the fire-box longitudinally into two chambers, and thus providing for alternate firing upon two distinct grates. It will be perceived that the theoretical requirements of the problem are far from being attained in this scheme, for the free access of air through the grate would but stimulate the rapid distillation of the coal, while the small supply of fresh air from above, admitted at a point so far distant from the surface of the fire where the temperature is too low already to permit of its chemical combination with the volatile portion of the coal; and practice has confirmed its inefficiency, for the experiments made by Messrs. Woods and Marshall, as recorded by Clark, show that when fired with coal, this boiler only evaporates two-thirds the amount of water evaporated with coke. It is true that Clark says, "with good management it is effectual in preventing smoke," but here we must remind our readers that any fire, when it is well managed, burns coal with little smoke.

The next scheme (Fig 6), originated by Mr. Yorston, was patented by that gentleman and Messrs. Sharp, Stewart, and Co., in 1855. Here the intention was to burn coke and coal simultaneously, the coke lying to the front, and the coal to the back of the fire box, and each portion of the grate was fed through a separate door; the fire box was literally divided into two compartments crossways by a curved midfeather connected with the back of the box and with the sides, but stopped short at a distance from the bottom sufficient to allow of a single system of fire bars being used for both fires; the mid feather was perforated with a series of hollow stays to allow the gases of combustion from the coal fire to escape, and a stream of fresh air was supplied from below close against the back of the fire box. With this scheme it was evidently expected that the combustion of the volatile portions of the coal would be completed after their passage into the front compartment of the box where it was supposed, no doubt, a sufficient amount of oxygen would be found for the purpose, and the separate current of air from underneath, apparently was expected to glide up, unchanged

at the back where its temperature would be raised considerably, to assist afterwards in the combustion of those gases in the upper region of the fire box; we are, however, unable to supply our readers with the practical results obtained by this experiment.

Almost simultaneously with the plan just described, Mr. Beattie of the South Western Railway, brought out his design, illustrated by fig. 7, which was intended to burn coal only. In this, as in the previous case, there are two distinct furnaces, and the fire box is divided into two compartments partly by an inclined midfeather, and towards the crown by an arch made of perforated fire bricks; the furnace to the back is the one most actively worked, and the one to the front is intended chiefly to carry incandescent fuel, so that the gases of combustion, issuing from the back furnace, and deflected by a hanging diaphragm may meet with gases at a higher temperature in the front compartment; the fire tiles also are intended to act as a reservoir of heat, raising the temperature both of the air let in through the upper firing door, and of the gases emerging from the back compartment. As in Mr. M'Connell's design, the fire box projects some distance into the boiler barrel, and in this front combustion chamber, there is again a diaphragm of perforated fire bricks to act as a reservoir of heat, and to promote a more perfect mixing of the gases in order to facilitate their entire combustion previous to entering the tubes.

This design, therefore, may be said to be a compound of M'Connell's and of Yorston's, with the only novel feature of the interposition of perforated firebricks, which we certainly are inclined to consider as an improvement; and if we are to put faith in the results of experiments made to test its efficiency as recorded by Clark, we cannot but conclude that it has given the most satisfactory results; for in this record we find that on one occasion it actually evaporated 10 lbs. of water per pound of coal, and that the average performance of 12 experiments was 8·6lbs. water per pound of coal, against 7·7lbs. per pound of coke. Time, however, has not verified those extraordinary performances, and at this date Beattie's coal burner belongs to the things of the past. The various schemes brought out since 1857 have all been much less pretentious than the previous ones, and proportionately also have they been more practical; indeed, with a few exceptions, they seem to have all had a tendency to realise the plan now adopted by Mr. Ramsbottom (illustrated by fig. 8) on the extensive net work of the London and North Western Railway, and consisting of a couple of air holes in the front of the fire-box, through which the admission of air is regulated by means of small dampers, a brick arch leaning from the tube plate slightly downwards to throw the fresh air upon the surface of the fuel, and also to increase the length of travel of the gases of combustion, and of a deflector leaning downwards from the firing door to throw the fresh air admitted through the latter upon the surface of the fuel also. Thus Mr. Yarrow, of the Aberdeen Railway, and Mr. Jenkins, of the Lancashire and Yorkshire Railway, simultaneously introduced the admission of air through the front along with the brick arch, while Mr. Peet, of the Carlisle Railway, and Mr. Ramsbottom adopted the deflector from the firing door, the whole combined forming a more effective smoke burning scheme than any other yet tried, and being extremely simple and inexpensive in its construction.

Mr. Sinclair, of the Great Eastern Railway, adopts the deflector over the firing door (see fig. 9); but instead of having a brick arch in front of the fire-box, he introduces two thin jets of steam on each side of the box, the object of which evidently is to mix the gases as much as possible before they enter the tubes. We do not think, however, that this scheme is as complete as the one previously described, because it does not afford the gases the increased length of travel obtained by the introduction of the brick arch.

To complete our review of the smoke burning schemes to which we have referred, we should add that each of them includes a blow-pipe, by means of which a jet of steam may be introduced into the chimney when the engine stops. This contrivance has the double effect of creating a slight draught, and of discolouring the smoke, which becomes more plentiful during these periods of slow combustion.

Before concluding our enquiry into the results produced by the combustion of coal, and in order to complete the comparison between the respective duties yielded by coal and coke we should remark that the evaporating power of the former being only two-thirds that of the latter, unless a proportionately greater amount of coal can be consumed in a given time upon the same grate area, all the engines originally designed to burn coke must be capable only of a proportionately smaller duty; and here, therefore, is another point which demands investigation.

We have thus become acquainted with the gradual growth of the knowledge on the capabilities of the boiler as an accumulator of heat or power, for it is now a well established fact that, in mechanics, these two terms are synonymous; and we have learned, so far at any rate as this knowledge at present permits, how to proportion that most important part of the locomotive engine to enable it at any time to meet a given duty. It remains now for us to glance over those questions which relate to its stability, for it should not be forgotten that the boiler is both an accumulator of power, and a reservoir of highly compressed gas, which seeks to make a way for itself wherever it can find a point too weak to resist its expansive force, when if it succeeds in so doing, from being a source of comfort and of wealth, it becomes a source of destruction and of sorrow.

It is a well-known fact that of all the structures which have to resist extraneous pressures, the arch is the lightest and the most effectual, and it is demonstrated (see *Rankine's Mechanics*) that an arch which is subject to an uniform normal pressure should be a circle; that boiler, therefore, is built correctly which is made circular, and to realise this condition should be the invariable care of the practical Engineer boiler maker. The peculiar circumstances, however, under which the locomotive boiler has to perform its work preclude the entire realisation of this condition of stability, and the universal practice now is to make the fire-box a square compartment walled round by an inner box made of copper plates on account of their greater conductibility of heat, and of their less liability to corrosion or oxidation, and of an outer box made of iron plates; a water-space of $2\frac{1}{2}$ to $3\frac{1}{2}$ inches is left between the two boxes, which are stayed together by means of screwed copper bolts rivetted down at the ends; at the bottom, the box is made tight by means of a ring, sometimes made of solid iron and sometimes of flanged iron; the crown of the inner box is generally flat, and stayed by a series of longitudinal bars known as the roof stay-bars, bedded accurately at each end upon the vertical walls of the box and rivetted, screwed, or bolted to the crown at suitable intervals in the whole of their length; finally, the crown of the outer box is made to follow the curve of the barrel, and generally projects some 5 inches or more beyond it; in recent practice, however, we find it to be more generally flush with the barrel, which is decidedly an improvement.

Having thus described the general design of the boiler, for the benefit of the uninitiated, the points which we shall have to inquire into are the following, viz.:—

1. What quality of iron should it be made of?
2. How should the plates be jointed?
3. How should the fire-box stays be distributed?
4. How should we proportion the strength of the roof-stay bars?

For the knowledge which we possess of these several points we are chiefly indebted to the researches of Mr. Fairbairn, a more untiring worker than whom we have not had in this important branch of physical science.

On the subject of the quality of the material, of course, there cannot be, and we believe there are not, two different opinions; it should be the best both in regard to its strength or toughness of fibre, and in regard to its ductility, for, owing to the peculiar construction of the locomotive boiler, the plates have to be flanged and worked into various shapes, especially in those portions attaching to the fire-box where iron of brittle grain, if it do not crack while it is being worked, will show its unfitness for the duty it has to perform after a very short time of service; the iron to be used, therefore, and, we believe, that generally used, is the best quality of Yorkshire iron, since the experiments made by Mr. Fairbairn, as early as 1838, show the ultimate strength of Yorkshire plate to be, on an average, 25 tons, and that of plates from other districts 21 tons only. Some experiments made by him also at the same period make the relative strength of plate joints to be as follows:—

Solid plate	100
Double rivetted joint	70
Single rivetted joint	56

And these figures have been confirmed by experiments since made at Woolwich by Mr. Bertram. This gentleman has patented a process for welding the joints of plates, and from his experiments it would appear that these joints are actually stronger than the plate itself when the weld is perfect; his process, however, has not yet found its way into general use, but the double-rivetted lap joint is now almost invariably adopted. Boiler barrels are made of plates varying from $\frac{3}{8}$ to $\frac{1}{2}$in., and the strain sustained by the plates for a given pressure in the boiler is

$$P = \frac{p \cdot D}{2240 \times 2 \times t \times 0{\cdot}7}$$

in which formula P is the strain upon the square inch of plate in tons, p the pressure of the steam in pounds per square inch, D the diameter of the barrel, and t the thickness of the plates, both in inches; from this we easily obtain also the pressure of the steam per square inch which would burst the boiler; assuming the ultimate strength of plate to be 25 tons, it stands thus

$$p_1 = \frac{25 \times 2240 \times 0{\cdot}7 \times 2 + t}{D} = 78400 \frac{t}{D}$$

which, calculated for a boiler 4ft. diameter, with plates $\frac{7}{16}$ thick, makes $p_1 = 714$lbs., and, as the maximum pressure of steam seldom exceeds 150lbs., or about $\frac{1}{5}$ the bursting pressure of a barrel of large size, there is no fear of accident on the score of over pressure. Before dismissing this subject, we would call the attention of our readers to Mr. Fernie's thick-edged boiler (a longitudinal section and plan of which is shown at Fig. 10, and a full size section of one of the thick-edged plates is given below the plan of the boiler), which supplies most effectually the deficiency of strength in the joints, and the peculiar feature of which consists in making the

plate thicker at the edges, and double rivetting the boiler at the same time. The full-sized sketch on our plate is intended to show the edge of the plate thickened to the amount of $\frac{4}{16}$, so as to bring the strength in the seams up to that in the body of the plate.

On the resistance of fire-box plates and stays, Mr. Fairbairn has made a series of direct experiments, from which we learn that with stays placed 5 inches apart the plates which were $\frac{3}{8}$ thick, began to bulge out under a pressure of 455lbs. to the inch, that is $\frac{1}{3}$ the maximum in the boiler; and with stays placed 4 inches apart they began to bulge out under a pressure of 515lbs. to the inch, or $\frac{2}{7}$ the maximum pressure, the copper plates, it should be stated, were $\frac{1}{2}$in. thick. Both experiments were pushed to the point of rupture, but, in a case like this, we have undoubtedly to deal with the question of *tightness*, since it is evident that the boiler is practically ruptured when it ceases to be tight, and which must take place whenever the plates begin to bulge out; 4in., therefore, should be the maximum distance of these stays, but it would be advisable to reduce it to $3\frac{3}{4}$in., since structures of much less importance are made to carry loads of $\frac{1}{4}$ or $\frac{1}{5}$ only their ultimate strength.

On the same ground should the roof stay bars and the bolts, or screws, which bind them and the crown of the copper box together be only 4in. apart; in practice, however, it is seldom possible to place the bars at closer distance than $4\frac{1}{4}$ or $4\frac{1}{2}$in., to counterbalance which, in some measure, the distance of the bolts may be reduced a little. In proportioning the strength of a roof stay bar we should look upon it as being a beam resting freely on the two vertical walls of the box, and subject to a load uniformly distributed over its length being that due to the steam pressure upon the narrow strip of $4\frac{1}{2}$in., the distance between two consecutive bars; a beam like this must satisfy to the general condition of the formula:

$$\frac{W\,l}{8} = \frac{R\,b\,d^2}{6}$$

where W is the total load in tons, l the length in inches, R the proof load of iron per square inch in tons, b and d respectively the breadth and the depth of the bar in inches. This formula applied to the present case with a maximum pressure of 150lbs. in the boiler, a proof load of 6 tons to the square inch and with the condition that the breadth of the bar shall be $\frac{1}{4}$ its depth, reads thus:

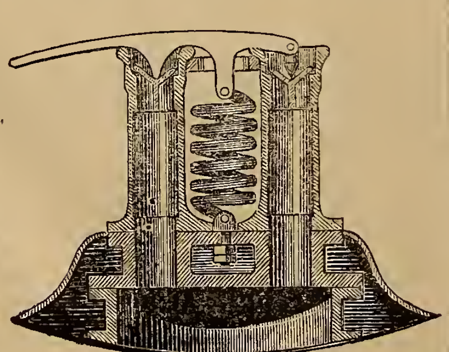
$$\frac{150 \times 4{\cdot}25 \times l^2}{2240 \times 8} = \frac{6 \times d^3}{4 \times 6} = \frac{d^3}{4}$$

whence we obtain,

$$d = \frac{1}{2}\sqrt[3]{l^2}$$

in the application of which formula it must be remembered that the bar must have a thickness equal to $\frac{1}{4}$ its depth, deduction being made for the bolt hole.

To give the steam the means of exit when it has reached its maximum pressure, or to give the engine driver the means of releasing it whenever that may be required, the boiler should be provided with a suitable safety valve, and of these we would say that *that* one is the best which is simplest in construction, and which affords either ignorance or malevolence the least possible chance of tampering with it. Among the many schemes which have at various times been advocated, two only deserve of our special notice, because they are the only ones which have come into general use. The first is the old valve with narrow conical seat, loaded by means of Salter's spring balance acting upon the end of a lever, which is so proportioned that the balance shall indicate the pressure of steam per square inch when it blows off; this is the scheme which has been mostly patronized until now, partly as a means of ascertaining the pressure in the boiler, although its indications may scarcely ever be relied upon to within 5 or 6 pounds.



The next scheme which the annexed woodcut illustrates, is the one patented by Mr. Ramsbottom, in which the old valve is preserved, but is held in its place by the direct pressure of a strong spiral spring adjusted to release the steam at the desired maximum pressure in the boiler. The cross bar which communicates the pressure of the spring to the valves is lengthened out in order to be used as a hand lever, and the arrangement is such, that any adequate pressure applied either upwards or downwards at the end of this lever will release the steam. This, indeed, is the peculiar advantage claimed for and possessed by this safety apparatus, inasmuch as the prevalent practice of overloading the safety valve is here an impossibility. This scheme is worthy of special notice, we think, independently of its practical advantages, on account of what we may be allowed to term its elegant ingenuity.

(*To be continued.*)

SCOTTISH SHIP-BUILDERS' ASSOCIATION.

ON ARMOUR-PLATING, &c.

BY Mr. Laurence Hill.

The protecting of war-ships has engaged the attention of naval men from a comparatively remote period; even the war galleys of our ancestors seem to have been protected against missiles, and to have been furnished with strong sharp bows for running down or injuring opposing vessels.

It is a curious fact, that while war missiles were comparatively feeble in effect, protection against them was deemed as necessary as it is now; whilst during a middle period, when the power of missiles had been greatly increased, it was thought hopeless to attempt any such defence.

The placing of plates at an inclination, though considered a new invention, is an old idea. In *Jamieson's Mechanical Dictionary*, published in 1827, there is a description of an invention by Louis Gompertz for protecting wooden ships with inclined plates, so as to deflect the shot, and of other plans, more ingenious than useful, for returning the enemy's shot against himself. His plan is shown at Fig. 1.

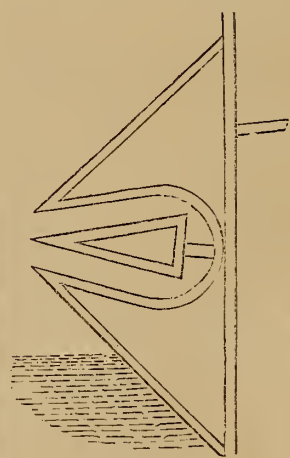


Fig. 1.

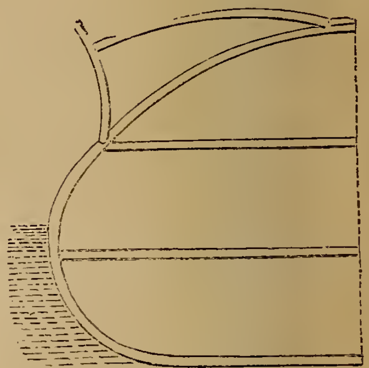


Fig. 2.

In 1836 Gompretz's invention was again brought before the public in *Herbert's Encyclopedia*. But the first time that I was aware of the principle of protection being brought before the Admiralty was in 1840, when Mr. M'Nair of Auchineen submitted his plans. In course of his correspondence with the Admiralty, Mr. M'Nair also showed the advantage of reducing the size of gun-ports—a matter now considered of much consequence.

In 1859 I submitted to the Admiralty plans for a gun-boat to be protected by plates placed at angles, both above and below the gunwale. This boat was armed with breech-loading guns, loaded from below, so as to keep the men under cover.

In 1861, Mr. Jones patented an invention for modelling war-ships, with an elliptical cross section.* Fig. 2.

Following up this invention, Captain Coles has gone very ably into the subject, advocating the advantage of *razeing* frigates, and protecting them by inclined plates.

The importance of armour plating is generally admitted; but two modes of applying it are advocated by different parties, viz., thick plates

* Mr. Jones does not patent the fixing plates at an angle, as is generally supposed.

placed vertically, and thinner plates placed at an angle so as to deflect the shot. Each party has proved by experiments that their plan possesses advantages peculiar to itself. Both are in some measure right. For while it has been proved by experiment that plates placed at a certain angle do not afford much more resistance than vertical ones, it has also been proved that, if the angle is sufficient, much thinner plates will suffice, and it likewise appears to be ascertained that the angle must be less than 45° to be of much advantage.

When the carrying capacity is limited, or the cost of thick plates too

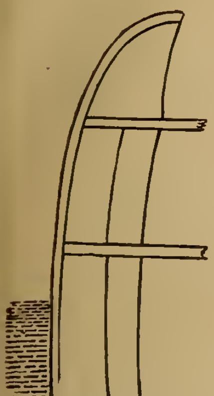


Fig. 3.

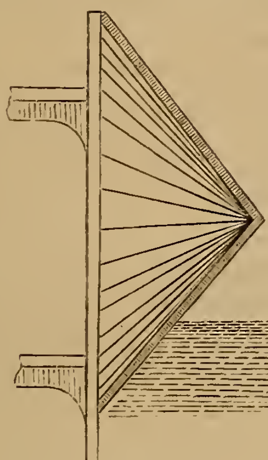


Fig. 4.

Fig. 5.

great, the thinner inclined plates may be adopted; but when otherwise, the thick plates are preferable. Both may be profitably combined in one ship. The thick vertical plates have this decided advantage, that, if strong enough to resist a point blank shot, should the heeling over of the ship present the side in an inclined direction to it, the efficiency of the protection would thereby be increased; whereas the opposite may be the case with the angled plates. Thick vertical plates have the further advantage of not encroaching on the vessel's deck space. On the other hand, the inclined plates cover a considerable portion of the ship's deck, and thus protect it from shot or shell dropping from an elevation, and also form a better protection for the men, who in small vessels, such as gun-boats, would require to remain on deck.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

I do not think the plan of arming only the centre of the ship is good The ship may be so built and protected in that way, by cross plates, as to protect the crew and not endanger the buoyancy of the ship; but if the ends are shattered, and hang loose, the vessel is rendered useless for manœuvring, or, in fact, for any purpose except that of a floating battery.

These remarks apply to vessels intended to come to close quarters with an enemy, and withstand the effect of broadside guns. But I apprehend that much money may be saved, and much more efficient service obtained, by the employment of very fast vessels, each carrying one or two guns capable of throwing heavy shot to great distances, but unprotected, their safety consisting in their ability to keep out of danger by means of superior speed and light draught; while the same means would enable them to harass an enemy. Such vessels would be of immense service in our channels and estuaries, either against an enemy's ship of the *Warrior* class, which they could assail from places where it could not venture; or could, if judiciously manœuvred, sink any ordinary ship of war. Besides, they would be exceedingly useful as sentinel and despatch boats.

Another very efficient description of vessel would be a long flat boat, very low in the water, say of the form patented by Mr. Jones, having a deck entirely covered with moderately thick plates, and armed with a few heavy guns. Such a vessel might steam close to a heavier ship, and do considerable damage with comparatively little risk, as shot would either pass over her, or would strike the covered deck at such acute angles as to be easily deflected.

To return to the subject of armour-plates, with a view to induce such discussion as may tend to elucidate the best description and best method of application, I may remark that when sufficient money and carrying capacity are available, we may take for granted that thick vertical plates are best for protecting the sides of ships, and may also take for granted that when plates can be placed at sufficient angles, a thickness of 2 or 2½ inches would be enough for ordinary protection. In that case their cheapness would permit of their application in the simple form of common flat plates, laid along from the ship's gunwale, and supported at the proper inclination by short stanchions or knee-plates.

The plan which is recommended by Captain Coles for the conversion and protection of wooden ships is well worth consideration. But for large ships yet to be built, thick plates might be fixed vertically from a few feet below the load water-line to the level of top of port-holes on gun-deck, and above that light plates, laid at an inclination, might be fixed to the vessel's frames and deck beams, these being properly shaped for the reception of the plates. The space for working the ship would be narrowed; but as masts and rigging should be entirely dispensed with, this is of little consequence. The disadvantage of greater difficulty in boarding an enemy's vessel is got over by having light folding gangways, which would also serve the purpose of bulwarks, as shown by Mr. Jones. The elliptical shape, as suggested by Mr. Jones, has, for vessels of shallow draught, the advantages of strength and lightness of frame. Mr. Grantham proposes to curve the ship's side from water-line, increasing the curve at the bulwarks, fixing the armour to the skin without wood backing, but increasing the rigidity of ship's sides by deep brackets, as shown in diagram fig. 3.

Several plans are suggested for using the conical or corrugated form of plating.

Mr. C. Richardson proposes fixing a row of conical shields all along the ship's sides, of section represented by diagram fig. 4, and of diameter equal to distance from water-line to gunwale.

Mr. Jevons proposes a series of conical plates laid on wood backing, as represented in diagram fig. 5; but thin corrugated plates, unless the corrugations are much larger than the ball, are all a source of weakness; for if the ball impinges against both sides, the immediate effect would be to wedge out or burst the plates asunder; and in fact this kind of collision of the ball between the plates tends to strengthen the ball, by keeping its particles from falling asunder; whereas, when it hits on the point the ball has a tendency to be rent. (See fig. 6.) Whatever the form or section of the vessel may be, it is self-evident that the thicker the shield, the better the protection. A thickness of 2 or 3 inches is easily attainable, but plates of 4 or 4½ inches thick at least are required for vertical positions; and recent experiments indicate that 6 inches may be required to give confidence. The problem of how to cover the greatest number of superficial yards at the least expense, is difficult to solve. Plates such as those used in the *Warrior* and *Black Prince* (see diagram fig. 9) say 15 feet × 3 feet × 4½ inches, exclusive of the wood backing and fitting, have cost nearly £50 per ton, or about £30 per square yard covered, for the material alone. If 6½ inches thick, the expense would probably be doubled; the expense of fixing would also be increased, though not in the same proportion.

If a vessel similar to the *Warrior* is to be protected all round, there would probably be 2,000 yards of the sides and ends to be protected; this, at £50 per yard, is no less a sum than £100,000, and as the most of this expense is caused by the extra cost (chargeable as extra) for the extra weight, there is great need of finding some mode of cheapening the armour. There is difficulty in furnacing and handling masses of red-hot iron weighing 3 tons and upwards, and great waste in the manufacture, as well as necessity for very powerful machinery. But if the weights can be kept under 30 cwt., and the breadths under 18 inches, it would make a material difference, as plates, or thick bars rather, of 15 or 16 inches broad, can be rolled for £15 per ton. The weak parts in common armour-plates are undoubtedly at the edges and round the bolt-holes. If a mode of fixing is

attainable whereby bolt-holes can be dispensed with and the edges of plates protected, a great advantage would be effected. Mr. Langley proposes and has patented a section of plate, as represented in diagram fig. 7, which protects the bolts and rivet-holes, and permits of the plates being secured to the ship's side. Mr. Robinson, of the Ebbw Vale Company, suggested a section of plate, as represented in diagram fig. 8, which does not require any bolts in the principal plates.

To combine the idea of getting rid of the bolt-holes with protecting the edges, and at the same time facilitate the renewal of injured plates, I propose a section of armour-plate or bar, and a fastening bar, as represented in diagram fig. 10, which, besides requiring no holes in the principal bars, has the further advantage of protecting the edges, these being guarded by the curved or conical form of the fastening bar. It also permits of an injured plate being taken out without disturbing any of the neighbouring plates, all that is required being to unscrew the fastening bar immediately below it, when it will drop, and be relieved from the fastening above.

It may be said that though there are no holes in the plates there are holes in the fastening bars. This, however, is remedied by the extra depth of these pieces, and their inclined and conical position.

A fastening, such as I have described, would also provide for the easy removal and replacing of a great part of the weight at the bow and stern of a ship, so as to enable it to be put in better sailing trim before setting out to a foreign station, and that the vessel might be more lively in rough weather.

Suppose a ship plated, as already described, in a fore and aft manner, to a foot or two above the water-line; but, where it is wished to have the plates moveable, let the fastening plates above the water-line be fixed vertically, then the heavier plates themselves could be fitted so as to be easily drawn up and stowed below. With suitable tackle, many tons of these bars could be drawn and lowered into the hold in a short time, and as easily re-shipped when required. Another advantage of these long bars, when placed fore and aft, is that they would add to the strength of the structure, whereas the present short plates tend to weaken it.

As to the mode of backing, I am of opinion that heavy teak backing is objectionable. It requires long bolts, and there is so much overhang in in the weight carried as will soon either start or break the bolts. The same weight of iron as there is of wood would be very much more effective; for instance, a square foot of teak backing, 12 inches thick, will weigh as much as a square foot of plate 1 inch thick, and a 4-inch plate laid on teak is not so strong as a 5-inch plate without it. There is not only 25 per cent. more inertia of plate to oppose the momentum of the shot, but there is also 25 per cent. greater depth of beam, so to speak, to resist the bending or bulging of the under side, as it is evident that before the wood backing can be of any support to the plate, the plate must have already yielded by bulging, and been injured to a corresponding extent. The information derivable from experiments made by the Admiralty tends to show this; but any one may test it by an experiment on a small scale scale, as follows:—Take a rod, weighing say $\frac{1}{2}$ cwt., having one end tapered and rounded off to $\frac{5}{8}$ inch diameter, and drop it perpendicularly down from a height on the plates to be tried. This has been tried with the following results:—When the length of fall was 33 feet, and a $\frac{3}{8}$-inch plate lay on another plate of same thickness, the blow indented the upper plate only about $\frac{1}{24}$th part of an inch, but did not bend it. When a 4-inch teak plank was between the two plates the indentation was a full $\frac{1}{16}$th of an inch and the plate was bent $\frac{3}{8}$ths of an inch in a length of 9 inches. When resting on pine, the indentation was about the same, but the curvature of plate was about 30 per cent. more. A square foot of teak, at recent prices, costs 10s. A square foot of plate, 1 inch thick, costs only 3s. 4d., or £9 per ton, leaving a good margin for extra weight.

Regarding bulwarks, the lighter they are the better, for the men should not be exposed on deck during action, and a light rail and netting is sufficient to protect them in working the ship, of which little should be required, as, instead of spars and a mass of rigging—all liable to be shot away, and liable to foul the screw and endanger the ship—the whole manœuvring of the ship when in action should be effected by the machinery.

I am not aware of the cost to the country for spars, sails, and rigging, nor for wages and maintaining of crews to work such vessels; but I am certain that the interest of the money which might be saved would go a long way to pay for extra coal, of which the only extra quantity required would be in moving from place to place. In action sails would not be used, and in a voyage, if time was of no moment, a reduction in speed would greatly reduce the cost of fuel. At all events, low jury masts, built telescope fashion, and capable of being easily lowered, or folded level with the deck previous to action, are what I would recommend.

To conclude, the sum of matter is, if vessels are to be protected at all, the ends require it as much as the centre. As to backing, there should be none, or only as little as is requisite to bend the plates. The bulwarks should be light, and the armour thick.

ROYAL INSTITUTION OF GREAT BRITAIN.

ON COAL.

By Warington W. Smyth, Esq., F.R.S.

The speaker commenced by proposing to select one portion only of a very large subject; and, neglecting chemical and statistical and mining particulars with reference to this important mineral, to confine himself to the physical conditions under which it is found to occur. The enormous value of the coal of this country might be understood from the simple facts that nearly 300,000 of our fellow-subjects find their employment in the coal-mines; and that the total quantity raised in 1860 amounted to no less than eighty-four millions of tons.

Mr. Smyth then proceeded to describe the nature of the various substances with which the coal is associated, referring to specimens on the table from the field of South Yorkshire. Comparison was made between the total thickness of carboniferous rocks or coal measures of different districts, as well as between the total thickness of coal (in the aggregate of the seams); and hence, it was shown, we have one reason for not estimating the value of a coal-field merely by its area, as we find it laid down in a geological map. Thus, the well-known Durham field, with a thickness of measures of about 2000 feet, has a total thickness of coal of 50 feet. The Derbyshire, 2000, and almost twice the thickness of coal; the North Staffordshire, 6000 feet of measures, and 130 of coal; whilst the South Welsh and Saarbrücken fields exhibit thicknesses of 12 to 15,000 feet, with a proportionate increase (especially in the latter) of coal.

A second reason for mistrusting area as a criterion of the importance of a coal-district, is the various forms into which the coal measures have been thrown or moulded by agencies operating at a later date in the earth's crust, whence some districts may exhibit by outcrops an indication of the full amount of their entire contents, whilst in others the beds pass with a gradual inclination beneath newer formations, through which they may nevertheless be accessible. As instances of this were quoted, the vast accession of mineral wealth added, even in the last twelve years, to the Westphalian coal-field, by the explorations carried out through the covering of cretaceous rocks which clothe the northern side of the coal-field, and the remarkable pit lately completed by the Duke of Newcastle, at Shireoak, which, commenced at a distance of several miles from any visible coal-measures, pierced the new red sandstone and magnesian limestone, and reached the "top-hard" coal at 515 yards in depth.

Mr. Smyth then described certain physical features produced in the coal seams subsequently to their consolidation, such as the *cleat* and *backs*, or various nearly vertical divisions, often more or less filled with carbonate of lime or iron pyrites, which add greatly to the amount of ash and clinker.

In referring afterwards to the principal families of plants which are found either in, or associated with, the coal, he wished to show that their occurrence throws a light on the origin of the coal-seams, which again becomes an important guide in enabling us to judge of the continuity of various fields, a question fraught with vital importance, in consequence of the rapid rate at which some of them are being exhausted. Thus the position of the stigmaria in the under-clay or floor of the seam, and of the stems of sigillaria, lepidodendron, calamites, &c., in the roof strata, point to the probability of the growth of the vegetable matter *in situ*. The existence of numerous upright stems, and especially those occurring so often and so dangerously to the miners in the roof of certain coals, is a strong confirmation of the gradual depression of the tract in which these plants grew; and Göppert has shown that the careful examination of a number of seams proves the existence in the coal itself of every family of plant which has been met with in the coal measures.

Thus much had referred to the true carboniferous period, in which it is commonly supposed that a vigorous vegetation first arose, but the speaker described his finding, a few months since, in the Laxey lead and copper mine, in the Isle of Man, at 120 fathoms deep, a seam of anthracite coal, three or four inches thick, in the midst of ancient schists, probably Lower Silurian. He then referred to coaly and lignitic beds in newer formations, and more particularly to the tertiary brown-coal, which in continental, and especially in Southern Europe, attains to great importance. The excellent preservation of the vegetable remains in the lignite, has enabled Unger and Heer to make accurate comparison with existing floras, and to show that the tertiary flora had nothing in common with our present flora in Europe, but an extraordinary resemblance to that of modern North America. This was especially to be noticed in closely similar species of the genera *Liquidambar*, *Liriodendron*, *Pavia*, *Nyssa*, *Robinia*, *Taxodium*, *Sequoia*, *Juglans*, *Glycyrrhiza*, *Cercis*, *Laurus*, *Rhododendron*, *Cissus*, and certain oaks and pines. There was hence no retreating from the conclusion, that at this portion of the tertiary period a land communication must have existed between America and Europe. Fragments of that land, with

relics of the same tertiary flora, still exist in Iceland and the Azores, with their *surturbrand* and lignites; and thus, that Atlantis, which is generally set down as a dream of the poets, is brought again into solid existence by the studies of the geologist. A relation of this kind at a comparatively recent period, throws a light on the causes of phenomena belonging to an earlier epoch, and will enable us to form conclusions, if not upon the absolute contemporaneity of certain beds or groups of coal measures, at all events upon the physical connection within a given period of the agencies which were forming coal not only in the various fields of Europe, but also in North America: and the speaker concluded by pointing out that the reasoning on the continuity among one another of our British coal-fields, or of them with those of Belgium and North France, depends on somewhat complex data, which scientific investigation can alone afford.

SPECIMENS OF COAL AND SHALE FROM STRAFFORD COLLIERIES.

No.	Order of Minerals from Surface.	Thickness.			Depth below Surface at Strafford Colliery.
		Yds.	Ft.	In.	Yards.
1	Black Shale above Joan Coal	5	2	3	
2	Joan Coal	...	1	8	30½
3	Bottom of Joan Coal........................	...	...	...	
4	Spavin—Floor of Joan Coal..............	...	2	0	
5	Black Rust	1	0	0	41¾
6	Shale—Roof of Flockton Coal...........	...	...	6	
7	Shale—Top of Flockton Coal	...	2	5	53½
8	Spavin—Floor of Flockton Coal.........	...	2	8	
9	Roof of Channel—Bastard Shale	...	...	8	
10	Top of Channel Coal........................	...	1	7	84
11	Coal and Spavin........................	...	1	2	86
12	Black Spavin	...	1	2	86yds. 1 ft. 2in.
12*a*	Cank Stoue........................	...	...	...	103
13	Shale 3 ft. above Fenton Coal...........				
13*a*	Shale 2 ft. above Fenton Coal				
14	Shale 14 in. above Fenton Coal	...	...	...	
15	Spavin—Roof of Fenton Coal	1	0	4	107
16	Fenton Coal (top)	1	0	0	
17	Roof of Parkgate Coal	...	...	...	
18	Shale at top of Parkgate Coal	...	...	...	
19	Top part of ditto	0	2	7	
20	Bottom part of Parkgate, Top Bed......	...	...	...	131½
21	Spavin—Middle of ditto	...	1	0	
22	Parkgate bottom bed	...	1	3	
23	Black Bind	...	1	7	210¾
24	Ironstone—"Silkstone Black Mine"...	2	...	...	
25	Coal—"Black Mine"	...	...	5	220
26	Stone Bind—top of Silkstone	9	0	4	
27	Brass Band and top of Silkstono Coal..	...	...	...	
28	Top part of ditto	...	2	11½	
29	Dirt from middle of ditto	...	...	4	231
30	Bottom Bed—Silkstone	...	2	7½	
31	Stone Bind—Floor of ditto	...	...	...	

INSTITUTION OF CIVIL ENGINEERS.

Nov. 11, 1862—JOHN R. M'LEAN, ESQ., VICE-PRESIDENT, in the chair.

Before commencing the business of the evening on this, the first meeting of the session, and in the absence of the president, the chairman said it was his duty to notice the loss the institution had sustained by the death, during the recess, of two of its most eminent members, Mr. John Edward Errington, vice-president; and Mr. James Walker, past president.

For upwards of thirty years, and indeed ever since the introduction of the railway system, Mr. Errington occupied a prominent position as an engineer, and, in conjunction with Mr. Locke, executed some of the principal railway works in Great Britain. He was, like his partner, Mr. Locke, a strong advocate for economy in the first cost of construction. By his death the profession had lost one of its most distinguished members, the institution one of its warmest supporters, and many of us a sincere friend, and one ever ready to afford advice, especially to his numerous pupils and assistants, whose interests it was his constant endeavour to advance. As many of his pupils were actively engaged in the practice of the profession, and had, through his influence, been enabled already to take good positions, the chairman expressed the hope that they would feel it a duty, no less than a pleasure, incumbent upon them, to communicate plans and descriptions of the works of their eminent masters, and so keep alive the memory of "Locke and Errington" in the Institution of Civil Engineers. Mr. Errington had proved his attachment to the institution, and his desire to see it prosper, by bequeathing to it the sum of £1000, free of legacy duty, and without attaching any condition whatever to the gift.

Mr. Walker was one of the oldest members of the profession, having been in active practice as an engineer for upwards of sixty years. He was also one of the earliest members of the institution, having joined it in the year 1823, and, after the death of Mr. Telford, became its president. For a period of eleven years, during which he so ably conducted its proceedings in that capacity, he was most devoted to its interests, and to his zeal and energy must be greatly attributed the eminent position it held on his retiring from the chair in 1845. Mr. Walker's name was associated with many of the greatest hydraulic works in England and Scotland, including lighthouses, harbours, bridges, embankments, and drainage. His opinion was much valued by the elder brethren of the Trinity House, by the Lords of the Admiralty, and by the Corporation of the City of London, and it must not be forgotten, especially at the present moment, that twenty years ago he laid down lines for embanking each side of the River Thames, which have never been improved. As the chairman had had the privilege of being in Mr. Walker's employment for many years prior to 1844, he had an opportunity of knowing his worth, and must express his gratitude for many acts of kindness, and state that it was Mr. Walker's constant endeavour to promote the interests of himself and others. Many members of the profession had also been trained in the same school, including Burges, Bidder, Hawkshaw, Borthwick, and Hartley. During his long and useful career he had secured the admiration and respect of numerous influential friends, as well as the regard of his professional brethren.

The chairman had much gratification in announcing that Mr. Walker having left at Mr. Burges' disposal the twenty-five remaining copies of "Telford's Life and Works," as well as the copyright and the copper-plates, Mr. Burges had, in the most handsome and liberal manner, presented them to the institution.

ON THE RAILWAY SYSTEM OF GERMANY.

By MR. ROBERT CRAWFORD, ASSOC. INST. C.E.

It was stated that in Germany, as in England, tramways had formed the germ from which subsequent enterprise developed the vast network of railways now extending throughout the length and breadth of the land. The oldest of these undertakings originated in a fifty years' "privilege," granted by the Austrian Government upon the 7th of September, 1824, for the construction of a line from Budweiss, in Bohemia, to opposite Linz, on the Danube—a distance of upwards of 80 English miles. Subsequently, a concession was obtained for a line from Linz to Gmünden, 42½ miles. The cost of the Budweiss, Linz, and Gmünden line was about £1877 per mile. The gauge was 3 feet 7½ inches, and it was worked by horses until 1854, when small locomotive engines were employed, first upon a portion of the line, and in the following year upon the entire length.

A proposal to adopt steam as a motive power, instead of horse labour, was carried into effect for the first time in Germany in the case of a railway, 4 miles in length, from Nüremberg to Fürth, which was opened for public traffic on the 7th of December, 1835. Thus Germany, possessing at the close of the year 1835 upwards of 108 miles of tramways, had up to the same time only 4 miles of railway properly so called. In the five following years railways were introduced into all parts of the country, so that at the close of 1840 there were twelve railways, either wholly or in part finished, with a total length opened of 377 miles. In the next ten years this had been increased to 1,487 miles; by the close of 1860 to 8,512 miles; and at the end of 1861 a total of 8,866 miles had been constructed, at an average cost of £16,400 per mile. Nearly one-fourth of the entire length was provided with double lines of rails. About 38 per cent. of the existing lines was Government property; 10½ per cent. the property of companies,

applied after the engine had run its first 46,109 miles, and subsequently worked by Government; and 51½ per cent. the property of, and worked by private or joint-stock companies. Further, it appeared that 39½ per cent. of the entire length was constructed by the different States; 24¾ by companies under a guarantee of interest, or a Government subvention; and 35¾ per cent. by companies at their own cost and risk; so that Governmeut aid had been granted, directly or indirectly, to nearly two-thirds of the entire system. These 8866 miles of railway comprised 62 different undertakings, as at present constituted, under as many different organisations, and were managed by 19 Government departments and 43 boards of directors.

At the close of the year 1861 Germany had, in addition to the railways, about 143 miles of tramways, constructed at an average cost of £3200 per mile.

With a view of establishing a common plan of action, and of regulating to a certain extent the relations of the different railway companies with each other, a society was formed in the year 1847 under the title of "The Association of Government Railway Directions," which now embraced the whole of the lines with very unimportant exceptions. Each company subscribed a fixed sum towards the general management fund, together with a variable amount depending upon its length, and was represented at the meetings of the association and in the debates in proportion to its importance. A code of laws had been drawn up and agreed to, which was revised from time to time, the rules expressing the decided opinion of the associated body upon all points usually involved in the construction and working of railways. The gauge was now universally throughout the country 4 feet 8½ inches. With regard to curves and gradients the rules laid down were—First, the radius of curvature should, if possible, not be less than 3600 feet in level land, nor than 2000 feet in hilly districts, except in particular instances, where it might be necessary to reduce it to 1200 feet, or even in very rare cases to 600 feet, but never less. Second, the general scale of maximum gradients admissible on railways was 1 in 200 in level districts, 1 in 100 among hills, and 1 in 40 on mountain lines. Several examples of sharp curves upon works already executed were then noticed. The increased power of locomotive engines had led to a severer character of ruling gradients being introduced than was formermy contemplated, and there were ample proofs in every part of the country, that the limits recognised at present as suitable for the working of locomotives had been reached. Many instances were then given of steep gradients and sharp curves, including a particular account of the Semmering railway, and of the mode of working it. As, however, a description of this railway had been brought before the Institution by Mr. C. R. Drysdale, in the year 1856 (Minutes of Proceedings Inst. C.E., Vol. xv., p. 349), it would suffice to say, that the experience derived from the working of the line went to show, that one of the goods' engines was capable of drawing up the inclines of 1 in 40. at the rate of 9½ miles per hour, a train whose gross weight varied from 100 to 165 tons, according to the state of the rails and of the weather at the time. The ordinary rate of speed was fixed at—

	Ascending. Miles per hour.	Descending. Miles per hour.
For express trains	$14\frac{1}{7}$	$16\frac{1}{2}$
„ ordinary passenger	$11\frac{3}{4}$	$14\frac{1}{7}$
„ goods, including military transport	$9\frac{1}{2}$	$9\frac{1}{2}$

The maximum number of trains which had passed over the line in one day was 72, counting both ways. This was during the Italian war. The ordinary number was 27, with from seven to eight carriages each. The line was about 27½ miles in length, was laid with a double way throughout, and had cost £98,270 per mile.

It appeared to be a general, although not a universal plan, in the case of all main lines, to prepare the earthworks and masonry for a double way throughout, but not to lay the second line of rails until the success of the undertaking and the requirements of the traffic demanded it. Some of the heaviest earthworks executed up to the present day were then alluded to, including one on the Southern State Railway of Bavaria, the greatest height of which was 172 feet, and which contained nearly 3,000,300 cupic yards of material. A list of the largest tunnels on the principal lines was next given.

Viaducts and bridges were treated under two headings:—first, bridges composed altogether of masonry, aud second, iron bridges. The views of the Associated Railway Directions on bridge building were,—1st. For bridges, arches of stone or good bricks were preferable to every other description of structure, except in cases which required very oblique bridges. 2nd, Timber bridges were inadmissible. 3rd, When iron bridges were made use of, the portion of the structure which sustained the roadway should consist either of wrought or rolled iron. Thus cast-iron bridges as well as timber ones were removed from the field of investigation, the former by negation, and the latter by direct condemnation.

Instances were then adduced and details given of several examples of stone viaducts and bridges of imposing dimensions and extent, including those over the Goeltzsch and the Elser Valleys, on the railway from Leipzig to Hof,—and the Neisse Viaduct on the railway from Kohlfurth to Goerlitz, in Prussia. The result of a series of experiments, for the purpose of ascertaining the best description of concrete to be placed round the foundations of the river piers in the latter case, give the proportions most suitable for yielding a quick setting, hard concrete at 22 per cent. of cement, 22 of sand, and 56 of small broken stones, not exceeding 2 inches diameter. In regard to the bridge over the River Neckar, on the railway from Frankfort-on-Maine to Heidelberg, it was stated that the depth of the keystone was somewhat over the minimum required both by Desjardin's formula and by that of Gauthey; but on the other hand it was so out of proportion with the huge thickness obtained from the method of Perronet, as to prove the total unfitness of this system for calculating cases similar to the one in question. Thus the

	Metres.
Neckar Bridge as actually built had a depth of	1·200
„ according to Gauthey's formula it required . .	1·125
„ „ Desjardin's „	1·140
„ „ Perronct „	3·241

In the case of wrought iron bridges the arrangement most usually adopted, when the spans were wide, was that of a lattice construction in some one of its various modifications. One of the earliest examples which was described in detail, was the bridge over the river Kinzig, at Offenburg, on the Baden State railway, in which it was considered that the arrangement of the material was not judicious, as,—1st, The dimensions of the ironwork were uniform throughout the length of the span. 2nd, Although a stronger lattice construction was adopted in the case of the central girder, still the top and bottom sections were of similar dimensions to the outside ones; and 3rd, The cross sectional area of the iron had not been properly proportioned to its different powers to resist compression and extension, where those forces acted. The bridge over the river Vistula, at Dirschau, on the Eastern railway of Prussia was next referred to. It consisted of six spans, each 397 feet 6 inches in the clear, the depth of the girders being 38 feet 9 inches, and the whole of the material in the superstructure being carefully proportioned to the nature of the strains to which it would be exposed.* The Marienberg bridge over the river Nogat, on the same railway, was likewise minutely described. The next examples selected were those over the Rhine, at Cologne and at Kehl, close to Strasburg; in the latter case the method adopted in constructing the foundations progressed at the rate of about 20 inches per day of twenty-four hours.

In addition there was also another bridge over the Rhine at Mayence, which consisted of thirty-two openings, having together a clear waterway of 3,134 feet 6 inches lineal measure. The ironwork in the superstructure was somewhat similarly arranged to that of the Saltash bridge, modified in some particulars as to the cross sectton and the form in which the material was applied, according to what was known in Germany as the system of Professor Pauli, of Munich, which gave a rectangular top to the beam instead of an oval one.†

Attention was then directed to the Permanent Way. It appeared that about seven-eighths of the rails in use were of the broad base, or contractor's pattern; the remaining one-eighth being composed chiefly of chair rails, with a small proportion of bridge-shaped ones. As to size, the rails were not less than 4½ inches in height by 2¼ inches width of head, and the surface was curved to a radius of from 5 to 7 inches. They weighed generally from 66 to 76 lbs. per yard. Fish-plates were now almost universally adopted for connecting the ends of the rails, and the joints were always supported by a sleeper; a wrought-iron chair being interposed between the rail and the timber. Recently, a trial had been made of the modern English system of leaving the joint free without any sleeper under it. The almost universal system of supports was that of cross-sleepers. They were of oak, where it could be procured at a reasonable price; but different descripttons of larch and fir were often used after being prepared by some chemical process to resist the tendency to decay.

The quantity and description of rolling stock in use on different railways in Northern and Southern Germany varied greatly; but as nearly as could be estimated at the close of the year 1861 there were

Locomotive engines	0·414 per English mile.
Passenger carriages, average 41·8 seats each .	0·807 „
Goods trucks, average lead 6·9 tons . .	7·040 „

Before any engine was permitted to be used, its boiler must be tested with hydraulic pressure to at least one-and-a-half times the maximum steam pressure which it was intended to sustain, and a similar test must be

* For further detailed particulars and illustrations of this bridge, *vide* Artizan Exhibition Supplement, No. 2, August, 1862.

† A full description and illustrations of this bridge will be found in No. 1, Artizan Exhibition Supplement, July 15th, 1862.

repeated every time an additional 36,887 miles had been made. The rate of speed was usually, for express trains, from 27 to 35 miles an hour, for ordinary passenger trains from 20 to 25 miles, and goods trains from 10 to 15 miles per bour, in each case exclusive of stoppages.

Nov. 18, 1862.

In the discussiou upon Mr. Crawford's paper on "The Railway System of Germany," it was observed that the paper contained an interesting description of various railway structures rather than treated of the German system of railways. The German system of construction was, in general, no more tban adopting, iu a greater or less degree, tbe plans which had been found successful in this country, with such modifications as the circumstances required; but their works would not, as a rule, bear comparison with those in England. For instance, the viaducts built from tbe designs of Mr. J. Miller, M. Inst. C.E., upon thc Glasgow and Dumfries Railway, were still unequalled in Europe for holdness of conception and excellence of workmanship, and in Lancashire there were viaducts 100 feet in height, and in otber places 150 feet in height; and in all these cases, instead of consisting of tier upon tier of arches, as was the practice on the Continent, there was only one tier of arches. With regard to the Dirschau and the Marienberg bridges, their mathematical construction had heen admitted to be faulty, there being a want of due proportion between the several parts, and their cost had certainly not heen less than £45 per ton.

One of the most remarkable examples of engineering on the Continent had not been noticed. This was the line from Cologne to the Prussian frontier, between Verviers and Liege. It was constructed at an early period in the history of railways, abounded in rapid curves, and comprised an extraordinary series of tunnels and viaducts.

When Mr. Vignoles, thirty years ago, laid out the railway from Brunswick to the foot of the Hartz Mountains, he introduced what was termed in this country the "Contractor's Rail," but what was better known in America and all over the Continent as the "Vignoles' Rail." At the same time, he strongly advocated the plan of fishing the joints first adopted in Germany.

The great principles which characterised tbe German system of railways were the simplification of the permanent way and the perfection of their statistics. All the companies were compelled, as in France, to give positive returns, under specific heads, of every detail of expenditure, and as these were published annually, the companies were brought into a wholesome competition for the reduction of the working expenses to a minimum. A recent inquiry showed that the expenses per train mile on two-thirds of all the German railways were within a fraction of each other. Although it would be advantageous to follow the same plan in this country, as by tracing every item of expenditure to its source it would readily be seen where economy could be effected, yet it was believed that the average expenses per train mile were less in Great Britain than in Germany, or indeed on the Continent generally. Late returns showed that on the Semmering Railway the working expenses exceeded the receipts, so that however advantageous that railway was to the Austrian Government, it was unprofitable as a speculation. The absence of preliminary and parliamentary expenses, and the possibility of obtaining land at its mere agricultural or town value, instead of paying an exorbitant price for it, led to economy in first cost. But, on the other hand, in no part of the world could work be done so cheaply as in England, whether measurement or weight of material were taken as the standard of comparison.

It was believed that, owing to the small cost, comparatively, per mile, due to the causes which had been mentioned, and to the absence of competition, arising possibly from the fact that Government had contributed aid, either directly or indirectly, to two-thirds of the entire system, German railways were destined to pay a remunerative interest to their shareholders. Until quite lately, Parliamentary Committees in this country appeared to consider that unlimited competition was beneficial; but experience had now proved that it was not desirable for the public, and certainly not for the shareholders. It was admitted that statistical returns were invaluable to Railway Companies, as enabling the directors and officers to trace the cost of each individual part of their system, it might be through a series of years, and thus at once detect any excess of expenditure. But the utility of the publication of such returns was very questionable, as it was impossible fairly to contrast the details of the cost of one system with those of another, without being fully acquainted with all the circumstances affecting the cost in each case. For instance, on some portions of the North Eastern Railway, the expenditure per mile amounted to nearly 80 per cent. of the receipts, whereas on others it did not exceed a minimum of 40 per cent. Within any particular system, where all the facts were known, such comparisons could be properly made, but as between two different companies, where the conditions were dissimilar, they would be worse than useless, as being calculated to mislead those who placed reliance on them. It was mentioned that comparative statements, prepared with great ability from exactly the same data, of the working expenses of the two companies resulted in deductions being drawn exactly the reverse of the facts. The rules of "The Association of Government Railway Directions," as to gradients and curves, were commented upou, as practically amounting to nothing; and tbe condemnation of the use of cast iron for bridges seemed to be without sufficient reason, as tbere were many admirable examples of tbe use of that material for railway bridges.

It was remarked that, some years ago a curve of seven chains radius had been laid down on a line in this country, and the trains were calculated to, and did run round it at the rate of 25 miles an hour; and if circumstances required it, there was no reason why curves of 300 feet radius should not be adopted. Witb regard to gradieuts, particular districts seemed fitted for certain inclinations: thus, for instance, in the West of England 1 in 70 or 1 in 80, and in other places 1 in 100, only could be obtained, except at a greatly iucreased outlay. The speed on Germau railways appeared to be lower than was necessary. On the Semmering Railway the express trains were limited to 14 miles an hour both in ascending and descending gradients of 1 in 40. It was asserted that tbis speed might be doubled with safety, and that the cost of working up the Lickey incline at 28 miles an hour was not greater than at 15 miles an hour. From 1840 to 1845, the speed on that incline was 15 miles an bour with passenger trains of seven or eight carriages; whilst from 1845 to 1855, owing to an increase of traffic, the trains were composed of from ten to twelve carriages, and they were conveyed up the incline, at from 28 to 30 miles an hour, at no greater practical cost.

It was observed that, so far back as the year 1848, the German governments had taken to the belief, that a special education for engiueers of all classes—mechanical and civil—was one of the first duties of a government. At that time there were regular colleges for the training of skilled workmen, and for the education of civil engineers, in most of the great cities of Germany. By these means a set of thoroughly educated young men was prepared, ready to acquire practical knowledge and to turn it to account, in a very short period of time. One result of this system had been, that whereas English locomotive engines were at first copied implicitly, tbe German engineers gradually took to making the designs for themselves, and to depart more and more from the established patterns, so that now, on most of the principal lines, the engines were made exclusively in Germany, in some cases at a less cost tban in tbis country, and it was said that a Berlin firm had recently tendered successfully for locomotive engines required in England.

In regard to management and economy of working, it was maintained that the public convenience was less cousulted on German railways than on English lines; there were fewer trains, the speed was very much slower, and the stations were further apart. The rate of fares in Germany had not been stated, but it was believed that for the transport of goods and minerals the charges were bigher. These were elements why larger dividends were realised on comparatively smaller capitals.

To this it was replied that in Westphalia, the centre of German industry, as many trains ran as on some English lines, and the speed of the express trains was 40 miles an hour.

With respect to the construction of German railways, it was believed that the earliest lines in Germany were offshoots from the schools of mines in that country; and though they had no doubt taken the first ideas of railways from their great projector, George Stephenson, yet they had been carried out by themselves; and tbat the earliest example of an iron lattice bridge was that across the Elbe at Magdeburgh, the wooden lattice having been previously adopted in America.

The growing prominence of Germany in the industrial arts was attributed mainly to the system of technical education, particularly of engineers, which prevailed there; and it was argued that the distance between the English and German engineers was an increasing one in favour of the latter, as was deemed to be evidenced by the superior character of the continental machinery in the International Exhibition.

One of the reasons why German railways had been executed so cheaply was attributed to the population supplying an excellent industrious class, and to the works not being pushed forward so hurriedly, by which the price of labour was artificially raised. Throughout Prussia the cost of the earthworks did not exceed from 8*d.* to 9*d.* per cubic yard, the German navvy receiving only 1*s.* 6*d.* per day. Very little plant was employed, the barrow runs were longer, and the embankments were chiefly executed in that way, instead of by tipping from waggons from a great height, which might account for their assumed superiority.

In conclusion it was submitted, that without venturing to depreciate that which was a valuable adjunct to practical men of all classes, yet undue importance must not be attached to mere technical education, in contradistinction to that practical knowledge which it was essential the engineer should bring to bear in the exercise of his profession. The history of engineering showed that the works which reflected the highest honour on this country had been carried out by men who had not received a special education, but who, being possessed of great natural genius, were enabled to take advantage of the national resources and peculiarities in such a way as to bring the profession to the high pitch it had already attained, and to command for English engineers universal respect.

ON THE UTILIZATION OF PEAT, WITH REFERENCE MORE PARTICULARLY TO THE MANUFACTURE OF HYDRO-CARBON OILS.*

By B. H. Paul, Ph. D.

The application of peat to some useful purpose, is a subject which has, at various times, attracted considerable attention; a vast amount of inventive ingenuity has been bestowed upon it; it has given rise to very sanguine, and I may say, in some cases, very aggravated expectations, and as a natural consequence it has been a source of proportionate disappointment. Notwithstanding the numerous attempts and proposals that have been made for utilizing peat, very little has been done as to inquiring into and elucidating what are really its capabilities and disabilities as a material for use in the arts. But a knowledge of these circumstances is an essential preliminary to any successful application of it, and I hope to be able, in some degree, to contribute to the acquisition of such a knowledge by bringing before this Society the results of several years' practical experience in the prosecution of this subject.

Taking for granted that the existence of enormous deposits of peat in various parts of the kingdom is sufficiently well known, and having regard more especially to its technical value, it will be unnecessary for me to enter into any consideration of the origin and formation of peat, or of the different views entertained on that subject. It will be sufficient for my purpose to consider peat as it exists now; and with regard to this point there are two modes in which it occurs, which I believe to be of importance as regards its application to useful purposes. In one case we find peat deposits in the form of what are called peat-bogs, masses of peat of considerable superficial extent, and generally of great depth, 20, 30, and sometimes upwards of 100 feet deep, where the uppermost layers are of a loose, fibrous, or greasy texture, and saturated with water to such an extent, in some instances, as to be incapable of affording any support to the foot. When the water is drawn off from these bogs by drainage, the peat is generally found to vary in character according to the depth at which it is situated, gradually becoming darker in colour, more compact, and having less evident indications of vegetable structure. At the bottom of such bogs, the peat is generally a black mass, of a clayey consistency.

In the other case, we find, situated on the slopes of mountainous country, peat deposits, which are never of very great depth, generally from 12 to 2 feet, and where the peat is sufficiently solid to be walked upon with ease. In these deposits the peat is of a more uniform texture and character throughout, than in bogs, although there is always a greater or less difference between the peat at the surface and that at the bottom. These deposits of mountain peat are very common in the Highlands of Scotland and in some parts of Ireland.

Mountain peat offers very much greater facilities for cutting than bog peat, and it is generally of much better quality. Bog peat, when dried, has very much the appearance of pressed hay; it rarely has a density of more than 300 or 400 —water being 1000,—and the cubic foot weighs only from 15 to 30 pounds; it would perhaps be useful to distinguish it by the term turf, from the true mountain peat, which when dried is dark brown or quite black, with little or no remains of plants in it; capable of taking a high polish when rubbed, and of a density greater than that of water, the cubic foot weighing from 53 to 78 pounds.

The method of cutting peat in the Highlands of Scotland is very different from that adopted for cutting peat from bogs. In the first place trenches are opened at distances of about ten yards apart; and, according to the nature of the ground, these trenches are made from 50 to 400 or 500 yards long. After removing the surface sod at the places where the trenches are to be cut, for a width of three feet, along the whole line of the trench, the peat cutter digs out the peat with a peculiar-shaped tool, in slices of about a foot square and three or four inches thick. As fast as these slices are cut, another man takes them off the peat iron and throws them on the surface, so as to spread them out as much as possible. In this way prisms of peat, measuring three feet in width and depth are cut out at intervals of ten yards, and the number of slices cut in each trench are just as many as a man can throw on both sides of the trench without shifting his position except from one end of the trench to the other as the cutting advances.

In succeeding years the peat is cut from the two banks thus formed in each trench, to a width of only 18 inches and a depth of three feet. The advantage of this system of cutting is that there is no necessity for removing the peat by barrows to the spreading-ground, a proceeding which is attended with considerable expense for labour. When the peat is cut in this way from a bank 150 yards long, it will give 75 cubic yards of wet peat, and the number of slices into which this is divided will be about 8000. Then as the banks are ten yards apart, there are five yards width of drying ground to each bank, or a superficial area of 6750 square feet to each bank of 150 yards long. Cutting it in this way every year, it would take ten years to remove the whole of the peat to a depth of three feet. As the banks are cut away in successive years, the area of spreading-ground on the surface is reduced, and some of the peat has to be spread at the bottom of the trench, the area of which increases as that of the banks' surface is reduced by the cutting.

The peat, cut to a width of 18 inches and a depth of three feet, from a bank of 150 yards long, is what is called an iron's work, and the 75 yards of peat so cut yields about ten tons of dry peat, so that to cut seven or eight thousand tons of dry peat would require 750 irons' work, or banks about 64 miles in length, and extending over an area of about one-fifth of a square mile. This area of ground would supply seven or eight thousand tons every year for ten years.

The cutting and spreading of peat in this way forms but a proportion of the cost of the dry peat. A far more considerable portion of its cost results from the labour of collecting the dry peat and bringing it to the place where it is to be used. Herein lies one of the greatest difficulties of employing peat on any very extensive scale. Whatever mode may be adopted for collecting the dried peat to one spot for use, the cost of carriage will increase in proportion to the increase in the quantity of peat consumed at that spot. Thus, for instance, in the case of a factory consuming 7000 tons annually, it would be requisite to carry the peat, on the average, a distance of one-tenth of a mile; if the quantity consumed were 70,000 tons, it would be requite to carry it an average distance of half a mile, and if the quantity consumed were 300,000 tons a year, it would have to be carried an average distance of two miles, or a mile and a half, inasmuch as the cutting-ground would extend over an area of eight square miles.

The extent to which this advantage affects any particular instance of the use of peat will depend very much on the skill exercised in laying out the ground for cutting the peat and disposing the banks and tram-roads, or other means for conveying the peat to the place where it is to be used; but it is a disadvantage which can only be reduced by such means within the smallest possible limits, and which is quite inseparable from the use of peat on a large scale.

Another prominent difficulty attending the use of peat consists in obtaining it in a dry state, fit for use as fuel or otherwise. Mountain peat, as it occurs naturally, contains as much as 80 per cent. of water, even when it has been well drained, and bog peat often contains very much more. Consequently, to obtain one ton of dry peat, five tons of material have to be dug and spread, and four tons of water have to be got rid of by evaporation. When mountain peat is cut in slices, as I have decribed, and spread out on the ground during dry weather, the drying goes on rapidly, the surface of the pieces acquire a kind of skin, which is not wetted again by rain, and the peat, in the course of a week, is sufficiently hardened to be handled; the pieces are then set up on edge, so that the air may play on both sides, and in the course of six weeks or two months, they are dry enough to be stacked or heaped up. But, unfortunately, peat districts are generally remarkable for a very moist atmosphere and for a great frequency of rain. In the Highlands of Scotland and in the Hebrides on the average there is rain four days out of six, and it is only during the months of May, June, and July that you can expect to have any continuance of weather favourable for drying peat. It is necessary, therefore, to obtain the utmost advantage of that period for the drying of the peat, and to do so, the peat must all be cut before the end of May at latest. On the other hand, if the peat is cut in frosty weather, and becomes frozen, it crumbles to powder when the thaw comes, and for this reason it is not safe to commence the cutting at all before April or even May. As a rule it might be said that the month of May is the only time available for cutting peat in the Highlands of Scotland, and more especially in the Hebrides, so as, on the one hand, to avoid the destruction of the peat by frost, and on the other hand to ensure the best possible chance of getting it well dried.

Notwithstanding the general moist condition of the air in those places, the boisterous winds which prevail are very efficacious in drying the peat; and if, during the month of May and early part of June the peat has got a certain amount of drying, and a skin has formed on the surface of the pieces, it may be considered safe, whatever kind of weather there may be afterwards. It may then remain on the ground, set up in little heaps, till the autumn, and will get the advantage of whatever dry weather there may be. Of course, even in this case, the quality of the peat will depend on the weather; but if the cutting is not finished by the end of May, there is always less probability of getting the peat in good condition.

It will be evident from these circumstances that the cutting of peat to supply a factory consuming any large quantity, must be an affair requiring considerable management, so as to get the work done in the short space of time available for it, and the difficulty of effecting this increases in proportion to the quantity of peat required to be procured.

Two men working together, one cutting and the other casting the peat, will, in good weather, get through about one iron's work in a day, equivalent to 10 tons of dry peat, so that if they were able to work every day during May, they would cut from 200 to 300 tons of peat; and to get 10,000 tons cut and spread, 100 men would be required for the whole month; and to get 300,000 tons cut and spread would require 3000 men to be employed for the whole month. It is unnecessary to dilate upon the difficulty of getting such a large number of men together for the work, and of organising a system for measuring the work done, and carrying on the general supervision of the peat-cutting on such a large scale; but I may mention that there are circumstances connected with the habits of the people in these districts, which are in some degree favourable to the carrying out of such an operation. The people are almost all fishermen, and the fishing season does not commence until the end of May or June, so that it would be possible to obtain many of these men before they go to the fishing, and thus the inconvenience of employing a large number of men for a short period would not be so great there as it would in most other instances. Moreover, these people are accustomed to hutting themselves with no small degree of comfort, in huts or bothies built of the surface sods of the peat, and they live in these, as a rule, throughout the Hebrides; so that a squad of 200 or 300 men find, on the ground where they are going to work, the materials for their encampment, and it is interesting to see the dexterity and quickness with which they construct these bothies.

Having now described the mode of obtaining the peat, and pointed out the two great difficulties involved in the supply of a large quantity of it for the purpose of fuel or for any other application, I will now request your attention to the nature of this material when it has been dried, and in the first instance as regards its application as fuel.

Even in the most favourable seasons, the air-dried peat retains a considerable amount of water—from 20 to 30 per cent.—as will be seen from the following results or analyses of different kinds taken from stacks a year old. (Table 1.)

This water cannot be separated from the peat except by kiln drying; but in order to illustrate the effect of this moisture on the value of peat as fuel, I will at first suppose that it has been so dried as not to contain any water. In that state the composition of peat may be taken as generally represented by the following proportions as compared with coal. (Table 2.)

Combustion, or that chemical process by which heat is generated from ordinary

* Paper read at a recent meeting of the Society of Arts.

fuel, consists in the combination of carbon and hydrogen with atmospheric oxygen.

TABLE 1.

LEWS PEAT.	Air-dried.	
	Per centage of water	Weight of a cubic foot.
		lbs.
1. Light brown fibrous turf..............	40	25
2. Blackish brown fibrous peat	26·71	53
3. Black peat very dense	25·39	54
4. " "	31·60	65
5. Brown peat	28·74	71
6. Browish black peat	27·76	78

TABLE 2.

	Peat.	COAL.				
		Welsh.	Newcastle.	Lancashire.	Scotch.	Derbyshire.
Carbon	60	83·78	82·12	77·90	78·53	79·68
Hydrogen......	6	4·79	5·31	5·32	5·61	4·94
Oxygen.........	32	4·15	5·67	9·53	9·69	10·12
Ash	2	4·91	3·77	4·88	4·03	2·65
	100					

The amount of heat produced by the combustion of any kind of fuel depends, therefore, on the amount of carbon and hydrogen it contains. The amount of heat produced by any particular fuel, or its calorific power, is expressed by comparison with the amount of heat produced by the combustion of carbon, which is taken as unity. Hydrogen gas, when burnt, produces an amount of heat three times as great as that produced by the combustion of an equal weight of carbon to carbonic acid. The calorific power of hydrogen is therefore three times as great as that of carbon. The per centage composition of a fuel being known, it is easy to determine its relative calorific power, that of carbon being = 1000. When the combustible portion of the fuel consists of carbon only, as in coke or charcoal, the per centage of carbon expresses the calorific power or relative fuel value as compared with pure carbon. When the combustible portion of the fuel consists of carbon and hydrogen, the per centage amount of hydrogen multiplied by three and added to the number expressing the per centage of carbon, gives the calorific power of that fuel as compared with carbon; but when the fuel contains oxygen besides carbon and hydrogen, a portion of either or both of these constituents equivalent to the amount of oxygen contained in the fuel, must be regarded as already in combustion with oxygen, and therefore as ineffective for the production of heat. In such cases it is only the surplus carbon and hydrogen, over and above what are equivalent to the oxygen of the fuel, which can produce heat by combustion; therefore, the greater the amount of oxygen in any fuel, the smaller will be the calorific power. In this respect there is a great difference between coal and peat. The presence of a large amount of oxygen in fuel affects the calorific power in two ways, viz., by reducing the per centage amount of carbon and hydrogen, and by rendering a portion of those constituents ineffective for the production of heat. For this reason the calorific power of absolutely dry peat is only 660, while that of coal is from 996 to 903. Hence it will be evident that the maximum capability of peat as fuel is necessarily far below that of coal, even when the peat is absolutely dry. But, as I have already pointed out, that degree of dryness cannot be attained except by kiln-drying; and, the ordinary air-dried peat of good quality contains one-fourth its weight of water. Here then is a further reduction of the calorific power of this substance, by one-fourth, or to 495; about one-half that of coal.

In some cases where peat is needed for fuel it is essential to have it quite dry, and then it is worth while to kiln-dry it; but there is no saving effected by so doing. The 25 per cent. of water separated by kiln drying requires for its separation a determinate quantity of heat and a proportionate consumption of fuel, which is equally consumed without useful effect, whether the peat be used as fuel in the air dried state, or whether it be kiln dried before it is used.

These simple considerations will be sufficient to show what a palpable delusion it would be to suppose that peat could possibly be in any way equal to coal in fuel value.

The greater bulkiness of peat as compared with coal is another circumstance which operates against its application as fuel. The average of coal has a density corresponding to 80lbs. to the cubic foot, while air-dried peat has a density corresponding to only 61lbs. to the cubic foot. A cubic foot of coal, in the state in which it is used, contains about 60lbs., whereas peat in the same way weighs only 30lbs. to the cubic foot; so that with only half the calorific power it takes twice the space, and to produce a given effect with air-dried peat, it would require twice the weight and four times the bulk of the coal to produce that effect. Hence has arisen the idea of compressing peat. It is notorious that no success has attended any of the attempts to carry this idea into practice, and that this should be the case is very easily intelligible. Absolutely dry peat of the very best quality has a fuel value of 660 as compared with coal at 960; in order, therefore, that equal bulks of coal and peat should have the same fuel value, a cubic foot of peat must contain nearly one and a half times as much in weight as a cubic foot of coal, or nearly 116lbs. to the cubic foot, corresponding to a density of 1800. Whether such a compression of peat is or is not possible in practice I will not pretend to say, though I consider it very improbable; and even if it were effected so as to be of practical utility, there would still be the disadvantage attending the use of peat as fuel, that its calorific power would be only two-thirds that of coal, and that one and a half times as much must be used to produce the same effect.

As regards the use of peat for fuel, it now remains only to consider what are the circumstances under which it can be used for this purpose, and under which there is an advantage in using it rather than coal. I can best illustrate this by a case within my own experience. During the last four years I have had occasion to manufacture a large quantity of bricks in one of the Western Islands of Scotland, and for that purpose required fuel for raising steam to drive the brick machinery, and for burning the bricks. Coal could be delivered at the port of Stornoway at about 18*s.* per ton, and as the works were at some distance inland, there was a cartage amounting to 4*s.* per ton, making the cost of the coal 22*s.* per ton. But I found that the peat, of which there was abundance close to the works, was capable of raising steam well, and of being used for burning the bricks, and that, taking it to have only half the fuel value of coal, and even with very imperfect arrangements for bringing it in from the moor, I could for 8*s.* put down at the boiler or at the kiln a quantity of peat equivalent to one ton of coal, thus making a difference of 14*s.* between the use of a ton of coal and the use of peat equivalent to it. As the burning of the bricks required about half a ton of coals per thousand, this was equivalent to a saving of 7*s.* per thousand in the cost of the bricks. In this case, therefore, there was an unmistakeable advantage in using peat as fuel, and the advantage would have been still greater if there had been a more efficient means of bringing in the peat from the moor. In the case to which I now refer, this cost as much as the peat itself cost on the moor, or about 2*s.* per ton.

In the town of Stornoway, however, it is found to be more advantageous to use coal at the gas works, and as fuel for the steam boiler at the slip, and for general purposes, since there is no organised system for supplying the peat from the moors, which are three or four miles distant from the town, the consequence being that the gathering and cartage of the peat costs as much as 4*s.* or 5*s.* per ton over and above the cost of cutting and drying, or in all 6*s.* or 7*s.* per ton. At that cost it is evidently better to use coal, which is much more easily obtained, and which, being double the value of peat, is not much dearer.

From my own experience of the use of peat as fuel, I consider that wherever it can be had on the spot, and with a fuel value one-half that of coal can be put down at a cost of 4*s.* per ton at the place where it is to be used, it may be advantageously substituted, when coal, under the same circumstances, costs more than 10*s.* per ton; but if coal can be had for 10*s.* per ton, or less than that, there would be a disadvantage in using peat.

When the place where peat is to be used is far distant from the moor where it is cut, the cost of carriage, under the most favourable circumstances, amounts to twice as much as the carriage of coal, because the fuel value being only half that of coal, two tons of peat are required for one ton of coal. This necessarily limits the use of peat as fuel to places near the moors where it is cut.

Besides the compression of peat, various other modes of improving it for use as fuel have been tried; the general principle of all these modes of treatment is the kneading or pugging of the peat, so as to give it a more uniform and compact texture and greater density. Peat which has been prepared in this way will have, when dried, a density equal to that of coal; but I have never been able to perceive how these operations can be advantageously applied to peat, for the following reasons:—In the first place it must be remembered that to obtain a ton of dry peat it is necessary in the kneading or pugging which is intended to improve its texture to operate upon five tons of material. Supposing that to be rendered practicable by suitable mechanical contrivances, so as not to cost more than it is worth or more than is proportionate to the consequent improvement of the peat, it must be remembered that this kneading or pugging of the peat does not separate the water—it does not dry the peat. This—which is the greatest difficulty of all in regard to the use of peat—still remains to be done, and even admitting that some of the water may be separated by the pugging, there will be at least three tons of water to evaporate in order to obtain one ton of dry peat.

The idea of employing heat to evaporate that water, or drying the peat artificially, is quite out of the question, since the consumption of fuel for that purpose would be quite disproportionate to the value of the peat obtained. The only plan of drying that is practicable is air-drying, and to dry peat by exposure to the air it must be spread out over a large surface. Every ton of dry peat will require 75 square yards of drying ground; and if the quantity of peat required every year is 30,000 tons, the area of the cutting ground will be one square mile at least. Now if the peat is to be submitted to the operation of kneading or pugging, and has then to be dried by exposure to the air, it must, if the pugging machinery is fixed, be carried to the machine, and then carried back to the spreading ground. This carriage to and fro will amount to ten times as much as the carriage of the peat itself, and must add considerably to the cost. If, on the other hand, the pugging machine be locomotive, another obstacle to the adoption of this plan of treatment arises from the necessity of carrying out the cutting and spreading of the peat within a very limited time, as I have already pointed out.

Now, when we consider all these circumstances, and compare the cost of applying this treatment to peat with the results effected by its application, I think it must be obvious to any one acquainted with the peat districts, with the use of machinery, and with the value of fuel, that the attempt to apply such treatment to peat is like breaking a fly upon a wheel, that the means are totally disproportionate to the end, and that the use of peat as fuel is altogether dependent on local circumstances, the principal of those circumstances being the

want of coal or the high price of it, and the presence of an abundance of peat of good quality. These are the circumstances which would determine the consumer of fuel in choosing peat or coal. It is entirely a question of cost. To the landowner there may be in some cases other inducements to promote the use of peat in place of coal, such, for instance, as the employment of a population which would otherwise be in idleness; the desire to clear away the peat and make land available for agricultural purposes; but these circumstances are all incidental, and of a nature foreign to the true merits of the question as to the value of peat as fuel.

I am quite convinced, however, that there are many places in the Highlands of Scotland, and perhaps also in Ireland, where the concurrent influence of a variety of circumstances favourable to the application of peat as fuel, is sufficiently great to admit of a vast amount of good being effected by carrying out the cutting of it on a large scale. Thus, for instance, steam communication between Glasgow and the various ports of the Western Islands of Scotland is still very expensive on account of the necessity of sending out the coal for the return passage of the steamers. The cost of the coal consumed in the steamers running between Glasgow and Stornoway is about £80 each passage, and there is much more than a mere probability that a judicious and liberal minded application of capital would be successful in establishing the use of peat as fuel in those steamers on their return passage to Glasgow. The applicability of the peat for this purpose is undubitable. I have employed peat as the only fuel for steam boilers during the last four years, and have found it to answer admirably. It has also been tried by Mr. James Napier, of Glasgow, on board his steamer the *Lancefield*, and he is of opinion that it might be used in the place of coal. The fact of its being only half the fuel value of coal would in this instance be counterbalanced by the advantage of its cost being less than that of coal. Besides this, the steamers running between Glasgow and the Western Islands are chiefly supported by the freights from Glasgow; their return cargoes are sufficiently small to admit of their using peat as fuel, although a greater weight and bulk would be needed of it than of coal. Moreover, the peat being a natural production and incumbrance of those islands, its use for this purpose would at once be a means of establishing a productive industry and also of affording what is so much needed there,—a great opportunity for employment—while at the same time the condition of the people would be bettered; and, by the removal of the peat, land would be cleared for cultivation, and the climate improved and rendered less unfavourable to vegetation. At present, however, the peat deposits of these islands and of the Highlands generally, though containing the elements of social amelioration, of industry, and of wealth, lie like a huge inanimate chaos, burying the land which might yield abundant harvests, preventing the labour of the inhabitants, and hindering the development and maturing of the crops on those few patches of ground which are yet cultivated.

The next application of peat, and that to which I purpose to refer more especially in this paper, is the manufacture of oils and paraffin from it by distillation.

It will doubtless be remembered that, in the year 1849, great interest was excited in Parliament and throughout the country by the announcement that a method of obtaining valuable products from the peat of the Irish bogs had been discovered, and that a company had been formed for the purpose of carrying out, on a large scale, the manufacture of those products from peat in Ireland.

The proposed undertaking was very warmly supported by the press, and was described in a popular journal as constituting an Irish El Dorado.

This mode of working peat was devised by Mr. Rees Reece. It consisted in distilling the peat in a kiln, much in the same way as Lord Dundonald, in 1781, distilled coal for tar, oil, &c., with this difference, that Mr. Reece employed a kiln constructed more in the form of an iron smelting furnace at the bottom, and that he employed, as in such iron furnaces, a blast of air for the purpose of maintaining the combustion of the peat at the lower end of the kiln, by which means heat was produced for distilling the peat at the upper part of the kiln. By thus distilling peat, a tar was obtained which, on subsequent distillation and treatment, yielded oil and paraffin.

In consequence of the very great public attention directed to this project, an investigation of the subject was instituted, at the suggestion of Lord Clarendon and the Chief Commissioner of Woods, by the chemical officers of the Museum of Irish Industry, under the direction of Sir R. Kane. The results of that inquiry were published in a Blue-book in the year 1851.

Among the products which were shown to be obtainable from peat, were paraffin and certain hydro-carbon oils, which it was proposed by Mr. Reece to use as solvents of india rubber and for lubricating machinery.

These oils and paraffin were obtained, in the first instance, as tar, by distillation of the peat, and the results given in Sir R. Kane's report go to show that there is no serious difference in the nature and amount of the produce,

TABLE 3.

KIND OF PEAT.	Pounds per cubic foot.	Peat Distilled in Retorts.			Peat Distilled in Kiln.			
		Per centage of Tar.	Per centage of Oil from Tar by weight.	Refin'd Oil from 1 ton tar, galls.	Per centage of Tar.	Per centage of Oil from tar by weight.	Refin'd Oil from 1 ton Tar, galls.	
1. Mixed light and dense turf (Phillipstown)	33·5	2·000	58·8	155	—	—	—	Sir Robert Kane and Mr. Sullivan.
2. Light surface turf (Allen)	21·0	3·577	46·1	121	2·510	55·3	144	
3. Dense peat (Allen).........	29·7	2·767	43·8	115	2·395	43·1	113	
4. Light fibrous turf (Ticknevin).........	30·3	2·916	70·2	184	—	—	—	
5. Light fibrous turf	30·3	2·344	64·2	168	—	—	—	
6. Light fibrous turf (Shannon)	17·5	4·417	38·2	100	—	—	—	
7. Dense Peat (Shannon)	53·3	1·462	70·1	184	2·270	50·0	132	
Average	—	2·787	55·9	147	2·391	48·5	128	
8. Dense mountain peat (Antrim)	—	—	—	—	4·440	—	—	Dr. Hodges.

whether the distillation of the peat be conducted in close retorts, or in kilns, as proposed by Mr. Reece.

The experiments that were made with different kinds of peat gave the quantitive results shown in Table 3.

There is some degree of discordance in these results, but, taking the average, it will be seen that the peat distilled in close retorts yielded nearly 3 per cent. of tar, and when distilled in kilns it gave nearly 2½ per cent. In the former case the tar gave, on the average, rather more than half its weight; and, in the latter case, rather less than half its weight of refined oils and paraffin.

It must be borne in mind that all the varieties of peat referred to in Sir R. Kane's report are true "bog peat," the only result quoted by Sir R. Kane for mountain peat being that obtained by Dr. Hodges, of Belfast, in 1850, from an experiment conducted by him with about 50 tons of peat at Newtown Commelin, in Antrim.

Taking the average of these results, the 100 tons of Irish bog peat would yield by distillation in close retorts 2 tons 15 cwt. of tar, which gave by subsequent treatment 409 gallons of refind oils and paraffin, and by kiln distillation the 100 tons would yield 2 tons 8 cwt. of tar, or 304 gallons of refined oils and paraffin.

If this tar, or the oils and paraffin it yields, be taken as the sole commercially valuable products from the distillation of the peat, and if the cost of the peat is taken as 2*s.* per ton, as set down by Mr. Reece, and quoted in Sir R. Kane's report, the tar would cost, for raw material alone, about £4 per ton, and the cost of raw material equivalent to one gallon of refined oils and paraffin would be 7*d.*

Adding to this cost of raw material the cost of making the tar and refining the oil and paraffin as amounting jointly to 1*s.* per gallon, the total cost of the refined product would be 1*s.* 7*d.* per gallon.

It is not very probable that at this rate of cost the manufacture of these products from peat would be very remunerative, especially at the present market price of these oils and paraffin; but in Sir R. Kane's report, which has especial reference to Mr. Reece's project for working peat, other products besides the oil and paraffin are taken into account as adding to the profits that might be expected from this undertaking.

These products are sulphate of ammonia, acetate of lime, and wood naphtha; and so much were they regarded as a source of profit to be anticipated from the working of peat, that in the prospectus of the Irish Peat Company they were set down as furnishing more than one-half of the expected profits of the works.

The values assigned to these products in Sir R. Kane's report are not indeed quite so great, as regards the amount, as those stated by Mr. Reece, but they are, nevertheless, considerable, being for the 100 tons of peat as follows:—

MR. REECE.

Sulphate of ammonia, 20 cwt. at 12*s*.	£12 0
Acetate of lime, 4 cwt. at 14*s*.	9 16
Wood naphtha, 52 gals. at 5*s*.	13 0
	£34 16

SIR R. KANE AND MR. SULLIVAN.

Sulphate of ammonia, 20 cwt. at 12*s*.	£12 0
Acetate of lime, 4 cwt. at 14*s*.	2 16
Wood naphtha, 52 gals. at 5*s*.	13 0
	£27 16

These results have a very attractive appearance, even in both cases; but a closer examination of the subject of peat working from a commercial point of view, led me to the conclusion that it is a fallacy to regard these products as constituting a source of profit to be obtained in working peat. On the contrary, I consider that no reliance should be placed on the value of these products as contributing in any way towards the possibility of peat beiug worked advantageously. They should be regarded strictly as waste or bye products, and the question whether peat can be worked remuneratively must he determined by regarding the oils and paraffin alone as the staple products. If these can be obtained in such proportion, and at such a cost as to afford a profit on the manufacture, it may then become a question to consider whether the bye products obtained in that manufacture are not worth working up for the sake of the ammoniacal salts and other materials they would yield. This question would be determined one way or another by a variety of circumstances of more or less special natnre. Among others, the possibility of making some portion of the waste of the chemicals employed in the purification of the oils and paraffin, available for working np these bye products, would be of prominent importance, inasmnch as that would, to some extent, reduce the cost of purifying the oils, &c.

I shall have occasion afterwards to poiut out results corroborative of this view as to the really valuable prodncts of peat.

Keeping this principle in view, meanwhile, I will now request your attention to the prodnction of paraffin and oil from peat. In the early part of 1858, I was consulted as to the possibility of working the tar obtained from the peat of the Island of Lews, one of the Hebrides. The peat occurring in this island is, as I have before mentioned, a true mountain peat, and, like most of the peat in the Highlands of Scotland and north of Ireland, is a remarkably rich bituminous variety. It is of a dark brown or black colour, and heavier than water, weighing sometimes as much as 78 lbs. the cubic foot. It burns with a brilliant white flame, of great length, and considerable heating power, indicating the presence of a large amount of bituminous substance.

The tar obtained from this peat by distillation was quite solid at the ordinary temperature; it was of a dark brown colour, with a penetrating odour of creosote, and melted on the fingers like butter, in conseqnence of the paraffin it contained. Its density was 0·960.

The analysis of this tar showed that it yielded hydro-carbon oil and paraffin of good quality. Two samples, one made in a close retort, the other in a kiln, gave the following results by weight :—

	Retort.	Kiln.
Refined oil and paraffin	42·161	41·167
Creosote	30·459	47·068
Charcoal, gas, and waste	27·380	11·765
	100·000	100·000

These quantities correspond respectively with 112 and 107 gallons of refined oil and paraffin from the ton of tar.

About a ton of the tar was then operated upon for the purpose of getting the products in such quantity as would admit of their being tested as to their applicability for various purposes.

The oil obtained from the tar was pnrified by the ordinary methods of treatment applicable to such materials, and was then separated by distillation into two portions; one portion of the oil, amounting to about one-half of the gross refined prodnct, was quite liquid even at low temperatures; it was of a pale yellow colour, with a slight and not unpleasant smell. It burnt well in the lamps commonly used for hyro-carbon oils, with a brilliant white flame. It did not carbonize the wick, while burning, or resinify by exposure to the air. Its boiling point being above 390° F., there was no danger of its giving off explosive vapour at any temperature it would be likely to be heated to when used in a lamp, and, as compared with some other oils of good quality, it gave, measure for measure, a greater quantity of light.

The other half of the oil was partly solid at the ordinary temperature; it consisted of an oil of greater density than the one I have just mentioned, and of higher boiling point, mixed with a great quantity of paraffin partly in solution and partly crystallised. This paraffin was easily removed by a filtering bag and the dissolved portion was separated, by cooling the oil and then filtering it again. The paraffin thus obtained amounted to about one-tenth part of the gross refined product. The oil from which the paraffin had been separated was, like the other oil, of a pale yellow colour, and had scarcely any smell. It burnt with an intense white luminous flame, and when mixed with fat oils formed an excellent lubricator.

The proportion of refined oil and paraffin which I obtained from the ton of tar was about 112 gallons in all; in round numbers it might be said that on a working scale the tar on which I operated would give 100 gallons refined oils and paraffin per ton. This was very much less than the average amount of the products obtained by Mr. Sullivan from the Irish peat, as stated in Sir Robert Kane's report; but, on the other hand, the amount of tar obtained from the Irish peat was very small, and I expected, from the difference between the peat operated upon by Mr. Sullivan and that of Lews, that this latter, being of a much more bituminous character, would yield by distillation a larger amount of tar.

With regard to the possibility of carrying on the manufacture of these products on a large scale, everything depended upon the cost at which the tar could be produced. Juding from the results that had already been obtained, it appeared to me that £5 per ton was the maximum price that could be allowed for the tar, supposing it to yield 100 gallons of refined oils and paraffin, and that with this cost for the tar, it would be possible to work it profitably if the purification of the oils did not cost more than six-pence per gallon.

These limits having been fixed as to the cost of tar and refining the oils, it became requisite to ascertain the cost of the peat, the amount of tar it yielded, and the cost of production. At that time the cost of the peat on the moor was 2*s*. 6*d*. per ton for cutting, drying, and stacking, by contract, but there were satisfactory reasons for expecting that it could be obtained at a less expense. These expectations were snbsequently realised, peat having been obtained by contract in succeeding years at 2*s*., 1*s*. 9*d*., and 1s. 6d., per ton; and some which I had cut under my own direction did not cost more than 1s. per ton stacked on the moor. I now think that from 1*s*. to 1*s*. 6*d*. per ton might be fairly taken as the prime cost of air-dried peat containing 20 to 30 per cent. of water.

(To be continued).

REVIEWS AND NOTICES OF NEW BOOKS.

The Mineral Resources of Central Italy, Including a Descripton of the Mines and Marble Quarries. By W. P. JERVIS, F.G.S., Assistant-Geueral to the Italian Special Commissioners for the Exhibition. London: Stanford, Charing-cross. 1862. Price 3*s*. 6*d*.

This work is one of a valuable series of books on the mineral resources of the various countries represented at the Internatioual Exhibition, 1862, in course of publication, and Mr. Jervis has performed, in a masterly manner, the task he undertook of bringing before the English public, in a succinct form the highly interesting and valuable statistics and scientific history of the mineral resources of that interesting geological country, Central Italy.

As the great source of supply to the wcrld of marbles for statuary and architectural embellishment are the quarries of Carrara and those adjacent, their productions are described minutely, but Mr. Jervis has not confined himself to the marbles, for although that subject has had ample justice done to it, in one chapter consisting of about twenty-two pages of letter press and the acompanying wood-cut illustrations, there are fifteen chapters in all, the remainder being devoted to alabaster, serpentine, boracic acid, rock salt, tin, copper, lead, silver, mercury, antimouy, manganese, the various metalliferous minerals, the etruscan art metal-work, and the mineral fuel and ores of Italy. Each chapter has peculiar interest, either scientific or commercial, and many both in an eminent degree. Mr. Jervis's book deserves the most extensive sale.

The Builders' and Contractors' Price Book for 1863. Revised by GEORGE R. BURNELL, C.E. and Architect. London: Lockwood and Co., 1863.

WE have in past years noticed this annual, and called attention to the alterations and improvements introduced from time to time. Mr. Burnell has, in the edition for this year, revised the prices for nearly all the trades included in the book, and has made various improvements which will be appreciated by all those for whom the work is intended.

This Price Book does more than maintain the good reputation it has so justly deserved, by keeping pace with the advances and changes made in the several trades, and thoroughly meeting the requirements of those to whom it is dedicated.

Solutions of Questions in Arithmetic by First Principles. By WALTER McLEOD, F.R.G.S., M.C.P. London: Longmans. 1863.

Mr. McLeod is the head master, &c., at the Royal Military Asylum, Chelsea, and is the author of some very useful and cheap arithmetical works, such as *The Six Standards of Arithmetic, A Manual of Arithmetic, Mental Arithmetic According to the Method of Pestalozzi*, &c. The present work is dedicated very appropriately to the Rev. Henry Moseley, M.A., F.R.S., the well-known and highly esteemed Canon of Bristol.

We extract the following from the author's "introduction" as the best explanation of the author's views, and of the nature of the work before us:—

"The present work, the result of many years' experience, contains full solutions of questions in simple and compound proportion, per centages, commission, interest, discount, stocks, profit and loss, and partnership, by first principles, in a form adapted for elementary instruction.

"In nearly all our text books in arithmetic, examples, such as those solved in this manual, are worked by statement, according to certain rules, which the pupil has first to learn by heart before he attempts the solution of a question. And when a pupil thus taught sits down to solve a problem, he generally finds himself involved in an impenetrable maze. He asks for guidance in his work, and is directed to the rule. He does as required; and by puzzling and repeated trials, he at length obtains the answer given in his book; but so far as the reasons of the process, and the principles of the rule are concerned, he remains in total ignorance.

"If there is to be any real, thorough teaching, the pupil must be made to understand the reason for every operation he performs. He is not to be a mere mechanical cipherer, but an intelligent agent—one who understands what he is doing, and can reason out every step in the solution of a question.

"The method adopted in this volume dispenses with rules altogether; and the most difficult questions in arithmetic, as will be seen on examination, are solved without statement, and by means of multiplication and division only. The method, moreover, is characterised by great simplicity; and every step in the solution of a problem is an intellectual exercise.

"But although the method has been so strongly recommended, and some authors of Arithmetical School-Books have adopted it in the solutions of easy questions, still no work has attempted to show that it is applicable to the most difficult problems in the higher branches of arithmetic. To bring the method, therefore, into more general use, and to supply teachers with a carefully selected series of questions, all solved by first principles, has been the aim of the author in the publication of his book of selectious."

The Engineer's, Architects and Contractor's Pocket Book for 1863. London: Lockwood. 1863.

The present publishers, Messrs. Lockwood and Co., deserve great credit for the improvements which have been introduced into the *Engineer's Pocket Book* since it came into their hands. The present edition contains several additions and improvements, and a few well-selected, scientific and practical papers, aud some brief memoirs of the scientific and other men of note recently deceased.

The tables for the reciprocal conversion of British measures of length, superficies, capacity, &c., into metric measures, aud similar tables for the translation of measures of weight, which have been much wanted, will be found a valuable addition amongst many others iutroduced in the *Engineer's Pocket Book* for this year.

Electrical Accumulation and Conduction. Part I. By F. C. Webb. London: E. and F. N. Spon.

The author has collected and published, in a small volume of 156 pages, a series of highly scientific and valuable papers, originally printed in *The Electrician*, a journal devoted to electric science, telegraphy, &c. It will also be remembered that Mr. Webb receutly read a very interesting practical paper upon the same subject before the Institution of Civil Engineers, which was esteemed as one of the best papers of the session. He is so thoroughly master of the subject, that a treatise on the principles of electrical accumulation and conduction could not have been written by any one more capable; and as the extension of the submarine or oceanic lines of electric telegraph mainly depends upon a more perfect knowledge of those laws which govern the economic transmission of currents through metallic wires (although doubtless these are questions of improved structural combinations and arrangement of parts of cables for deep sea lines), the present work serves to call the attention of those who are engaged in electric telegraphy to most grave and important questions.

An Inquiry into the Deposition of Lead Ore in the Mineral Veins of Swaledale, Yorkshire. By Lonsdale Bradley, F.G.S. London: Stanford, Charing-cross.

The author has pursued his investigations into the mineral characteristics of the mountain limestoue formation of Swaledale in a most careful, elaborate, and highly scientific manner, and in the volume before us has given a series of ten coloured sections of the various veins and stratifications comprised within an area of about 200 square miles; the number of distinct metallic veins cut and more or less explored being 192, of which number about 170 are said to be fairly productive.

The work is highly deserving of the attention of geologists and mineralogists, as most of the facts that result from Mr. Bradley's inquiry, and recorded by him, may with great advantage be applied elsewhere.

Mathematics for Practical Men. By Olinthus Gregory. The Fourth Edition, revised and corrected by J. R. Young (formerly Professor of Mathematics at Belfast College). London: Lockwood and Co., 1862.

Olinthus Gregory's *Mathematics for Practical Men* having justly earned almost a world-wide reputation in years gone by, it is unnecessary to do more than announce the publication of the fourth edition, after a careful mathematical revision by Professor J. R. Young.

The portion devoted to Pure Mathematies may be said to be uuexceptionably excellent; but we cannot forbear suggesting that there is to be found in Part 2, under "Mixed Mathematics," much that is obsolete, and should be omitted—as being useless to practical men, aud likely to mislead the student. The illustrations of quaint kinds of steam engines aud machines—still retained at the end of the book—gives it an air of antiquity which ought not to attach, for as a standard work ou mathematics it has not been excelled.

NOTICES TO CORRESPONDENTS.

R. C.—Your communication is to hand. We shall be glad to receive and give due consideration to the observations upon the subject to which you refer. We will write you in reply to your postscript.

"Aspel."—Yes. We will insert the particulars, if possible, in our next.

Constant Reader.—The date of Weston's Patent is April 25th, 1859.

W. R.—Your notes are to hand. We have used them, as you will perceive.

J. W.—We should take thefollowing formulæ:—$F = R \times P$. $R = \frac{F}{P}$ where R = the co-efficient of friction. P the pressure aud F the friction. The co-efficient R varies from ·054 to ·15. The variation depending upon the lubrication of the metal. The formulæ of Whitworth are well adapted for your purpose.

Errata.—*Locomotive Engineering.*—In the Artizan of Dec., p. 270, second column, where criticising Mr. D. K. Clark's formula:—$\left(R\,t = 6 + \frac{V^2}{240}\right)$ line eleven of the paragraph immediately following the above formula, for the words to the *square* of that speed, *read* to the *cube* of that speed; and after the word *speed* in the same line, insert the following:—*whereas it is one of the fundamental laws of mechanics that such work is proportional to the square of the speed.*

Obituary.

THE EARL OF GIFFORD.

We have to annouuce the death of the Earl of Gifford, which took place at Dufferin Lodge, Highgate, on the morning of the 22nd December, 1862, after a protracted illness. The deceased was the eldest son of the Marquis of Tweeddale, aud was born 1822, at Yester House, Haddingtonshire. He was educated at Trinity Hall, Cambridge, where he graduated M.A. in 1845. The deceased earl was well known for his scientific attainments, and was one of the first who was elected on the Committee on Steam Performance, appointed by the British Association for the Advancement of Science, of which he remained a very zealous member up to the time of his decease.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceediugs of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the iuventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, aud intelligible shape.

Spencer *v.* Jack and Rollo.—This was an action tried in the Court of Common Pleas, lasting three days, and concluded on the 17th ult., brought on behalf of a consulting engineer, of Newcastle-upon-Tyne, against the defendants, engine makers of Liverpool, for the infringement of a patent taken out by the plaintiff in 1860, for certain improvements in marine steam engines. Mr. Lush, Q.C., Mr. Streetou, and Mr. T. Webster appeared for the Plaintiff; Mr. Bovill, Q.C., Mr. Hindmarch, Q.C., and Mr. T. Jones for the defendants. The claim of the plaintiff under his patent was twofold:—first, in the arrangement of inverted direct acting screw engines, a disposition of surface condensers, by which the external casing thereof forms part of the main framing, aud is placed between and under the cylinders of such engines, and the tubes whereof, being horizontal and inclined, are placed across the line of the keel or propeller shaft; secondly, in the arrangement of paddle wheel engines, a disposition of surface condensers, by which the external casing thereof is placed between the cylinders, and may or may not form part of the main framing of such engine. The tubes whereof of such condensers, being horizontal or slightly inclined, are placed across the line of paddle shaft and in line with the keel. The defendants denied the novelty of the invention, but, after a short deliberation, the jury fouud for the plaintiff as regarded both cases.

Kottula *v.* Palmer and Others.—This was an action tried in the Court of Queen's Bench, on the 12th ult., by the assignees of Messrs. Blake and Maxwell's patents for improvement in the manufacture of soap, dated August 30th, 1856, against Messrs. Palmer and Co., the well-known patent candle and lamp makers. After the time of the Court had been occupied some two days, some witnesses for the defendant proved that soap, precisely the same as that the making of which was alleged to be an infringement of the plaintiff's patent rights had been made from a recipe in Kurten's book upon the subject before 1856, and soon after the work was known in England in 1853. The plaintiff elected to be nonsuited. The Lord Chief Justiee said the case furnished another proof of the unsatisfactory state of the law as regard patents.

Clark *v.* Metropolitan Railway Company.—This action was brought to recover damages for injury done to two houses at Cow-cross by the works of the underground railway. It appeared that it was necessary to divert a certain sewer in order to construct the railway at Cow-cross, and in consequence of the excavation for that purpose the houses of the plaintiff were so damaged as to require rebuildiug. The alleged negligence on the part of the defendants was that they had brought the uew sewer too near the houses when they could have taken it in another direction where it would not have affected the safety of the buildings, and that the houses were not completely and effectively shored up before the excavation. The works were executed for the Company by Mr. Jay, the contractor; and it appeared with the sanction and under the supervision of the Board of Works. The expense of rebuilding the houses was estimated at £1200, and the defendendant claimed £700 as compensation from the company, the difference being the increased valne of the property after the rebuilding. On the part of the defendants it was submitted that the contractor who did the work was liable for any injury done to the property, and not the company. Mr. Baron Martin held that if the company employed a contractor to do certain works, that did not relieve them from responsibility for the general mode in which they had been carried on. A verdict was ultimately returned for the plaintiff—Damages, £700.

Mare *v.* Churchward and Another.—In this case the plaintiff (the well-known ship-builder) sought to establish his right to a moiety of the net profits arising from the government contract for the conveyance of the mails between Dover and Calais, and Dover and Ostend, and also to a moiety of the profits arising from a contract with the French government for the conveyance of the French mails between Calais and Dover. The bankruptcy of the plaintiff was, as our readers are aware, superseded, upon his paying his creditors 4s. in the pound upon their debts. This he did with the assistance of his father-in-law, Mr. Peter Rolt, who had proved a debt against the plaintiff's estate to the amount of £133,000. Instead, however, of taking the composition upon his debt, it was arranged that he should, under a deed executed under the sanction of the commissioner in bankruptcy, have an assignment of the surplus assets of the estate after payment of the composition, including the beuefit of the contract for the Dover mail service. According to the case made by the bill, a sub-arrangement was made between Mr. Rolt and the plaintiff that the former would re-assign to the plaintiff the interests in these contracts upon the payment of the sum of £5000. On the other hand it was contended, on the part of Mr. Rolt, that another sum of £7031 was to be paid to him, in addition to the before mentioned sum of £5000, before the re-assignment could be asked for; and that the plaintiff, not having teudered both the sums referred to, Mr. Rolt, in 1858, assigned the interest in the Dover mail service, vested in him under the deed of arrangement, to Mr. Churchward, for a valuable consideration; and the present suit was instituted for the purpose of impeaching the latter assignment. His Honour, without calling upon the defendant's counsel, said that if Mr. Rolt had even entered into the contract to re-assign to the plaintiff the benefits of the mail service contracts for the sum of £5000 only, the plaintiff had been guilty of great *laches* in not sooner seeking the assistance of the Court; aud, upon that ground alone, the bill must stand dismissed with costs.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts (for which we are chiefly indebted to the *Chemical News*), Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Large Casting.—Ryhope, one of the largest collieries in the North is at present worked by one shaft. The owners, however, have determined to proceed at once with the formation of a second one, and for this purpose they have ordered Messrs. Murray, of Newcastle-on-Tyne, to erect an engine of 200-horse power, to assist in the sinking of the shaft, and to draw up the coals when it is completed. Recently the single cylinder of this engine was cast in Chester-le-Street Foundry. The cylinder, which is 68 inches in diameter, 8ft. 6in. in length, and 8 tons in weight, was cast with complete success, and the sight was a very interesting one. Some idea of the extent of the casting may be formed when it called into requisition two large smelting furnaces, ten tons of molten metal, and upwards of fifty men, besides three large cranes. When this engine is completed Ryhope Colliery will be worked by three 200-horse power engines, capable of drawing the enormous quantity of 3000 tons of coal per diem. Messrs. Murray are also engaged in building, for the same mine, two double-cylinder horizontal engines, of 200-horse power each, for the underground workings.

A Merchant Steel Ship.—Messrs. Jones, Quiggen, and Co., of Liverpool have lately contracted to build of steel, for a merchant house, a vessel of 1200 tons. This will be the first merchant vessel built of that material. The plates will be manufactured at the Mersey Steel and Iron Works.

Centrifugal Pumps.—The successive improvements which may be traced through the class of water wheels as chief motors in transmitting power, in which the modern turbines are conspicuous, have also suggested a reverse action, by which the wheels and turbines are changed into pumps, of which many different patterns are now, and have long been, in use, operating as suction and force lift pumps. The laws of maximum useful effect, which have been very fully and clearly demonstrated for water wheels, as types, apply to their reversed patterns, as to the form and arrangement of the blades, experiment having demonstrated a large increase of the discharge with a change from ordinary radial to properly curved arms, without increase of power. The following abstract of an experiment by Colonel Morin, made at the Exhibition, illustrates this point;—

Form	Revs. per minute.	Gallons raised per minute.	Height raised.	Useful effects.
Curved vanes (Appold's)......	792	1164	18 ft. 8in.	·649
" "	788	1236	19 ft. 4in.	·680
Inclined vanes (45 deg.)......	694	560	18 ft.	·394
" "	698	736	18 ft.	·434
Radial vanes	624	369	18 ft.	·232
"	720	474	18 ft.	·243

With the best form of pump which can be devised, useful effect is controlled by velocity and lift, and the value of this motor is confined to low lifts under excessive speeds. Experiments made on Appold's centrifugal pump show a progressive per centage of work done under a lift of 5·5ft., with a 12in. pump, of 21·2 per cent. for 375 revolutions; 59·1 for 400; 71·9 for 495; an increase to 607 revolutions giving 69·2 per cent. To raise water 67·66ft. required a speed of 1·322 revolutions; and within their special range of application, 70 per cent useful effect is all that can be claimed for the best motors of this class. The laws of form, however, have been much overlooked in those in ordinary use, radial blades being common in practice. For baling large quantities of water from foundations in excavation, and for other uses where the supply carries much sand and gravel, and the facility with which dirt, gravel, grain, &c., are passed through these pumps is a strong point in their favour, while they have no claim to merit on the ground of economy in power.

Explosive Compounds.—M. Reny, of Vienna, has patented the manufacture of an explosive compound by treating cotton or other lignin substance, whose chemical formula is $C_{12}\,H_{10}\,O_{10}$, with nitric acid in a peculiar manner, whereby he obtains an explosive compound $C_{12}\,H_7\,N_3\,O_{22}$, which may also be expressed $C_{12} + H_7\,3NO_4 + O_{10}$. The cotton yarn is loosely twisted; washed in pure running water, or under a fall for 48 hours and squeezed; dried in chambers at 122° Fahr. for 6 to 12 hours; the perfectly dried yarn is treated with monohydrated nitric acid of 1.52 sp. grav., and monohydrated sulphuric acid of 1.14 sp. grav. The acids are mixed and allowed to rest for 24 hours; the yarn is immersed in this mixed acid for 48 hours in pots under covers, and frequently stirred; the excess in the yarn is then thrown off by submitting the yarn to the action of a centrifugal machine; the yarn is then washed in fresh running water for 48 hours or upwards, and again dried; soaked in silicate of potash and squeezed; it is then washed for six days in running water, and dried, an excellent gun-cotton being the result. The cotton is most explosive, but entirely free from self-explosion, its explosion is not attended with smoke; its power can be regulated at pleasure; and, weight for weight, it has a force equal to six times that of the strongest gunpowder.

Effect of Galvanic Action on Iron Ships.—It appears that it has now been proved beyond question that the coating of iron ships with preparations of copper, results in a galvanic action which entirely destroys the iron plates, by converting them into a substance much resembling plumbago. The effect of this action has become very manifest in the case of *La Gloire*, the whole of the plates of which will have to be removed below the water line, and in one of our own ships the action has been no less remarkable. Fortunately, however, the Admiralty have now adopted a substitute, which entirely obviates the difficulty. The *Triton* has been thoroughly repaired at Devonport Dockyard, and is now coated with Messrs. Peacock and Buchan's preparation. It will be recollected that some years since Capt. Peacock issued a pamphlet on the subject, and that more than two years have elapsed since he pointed out to the Ministers of the Marine in Paris and Madrid the danger of using copper.

Tenders for British Iron for Government.—The tenders for the supply of British iron to Her Majesty's dockyards were recently opened, in the presence of the Lords of the Admiralty. There was considerable competition in the iron trade for this extensive contract, judging from the large attendance of representatives of the leading firms and manufacturers of Staffordshire and London. The successful competitors were the old established firms of Moser and Sons, of Southwark and Upper Thames-street, who have held the contract for six years.

Manufacture of Iron and Steel.—An improved apparatus for manufacturing malleable iron and steel has been patented by Mr. E. B. Wilson, of Parliament-street. The apparatus is a new form of Bessemer's converting vessel, in which the air is conveyed through a throat from the bottom instead of through tuyeres in the usual manner. The throat is turned up so as to form an inverted syphon, and when the iron is sufficient aerated, the vessel may be turned on the trunnions upon which it is hung, and the refined iron or steel poured into the ingot moulds, or otherwise.

Safety Valves of Steam Boilers.—At a meeting of the Academy of Sciences of Vienna, M. de Burg gave an account of his experiments on the mode of action of the safety valves of steam boilers. These results are in contradiction with the theoretical propositions upon which the regulations for the dimensions of these boilers have been based, inasmuch as in reality these valves do not rise to a height equal to one-fourth of their diameter, that is, one or more inches, but only so as to leave a passage for the steam whose diameter does not exceed the fraction of a line. These apparatus, therefore, cannot fulfil their object, which is to give simultaneous issue to all the steam which a boiler can produce when it has reached a determinate degree of tension, and thus to prevent all danger of explosion. To fulfil this purpose they ought to be at least six times, and in some cases twenty times larger than the rules prescribe.

Manufacture of Steel.—An important discovery has been made by Mr. Anderson, the Assistant-Superintendent of Woolwich Arsenal, of a simple process, by which steel is rendered as tough as wrought iron, without losing its hardness. This change is effected in a few minutes, by heating the metal, and plunging it into oil, after which the steel can be bent, but not easily broken.

The Electric Lamp for Lighthouses.—In one of his reports on the Dungeness light, written during the present year, Professor Faraday mentions an interesting experiment. Arrangements were made on shore (Mr. Holmes being in charge of the light), by which observations could be taken at sea about five miles off, on the relative light of the electric lamp and the metallic reflectors with their Argand oil lamps. At the given distance the eye could not separate the two lights, but by the telescope they were distinguishable. The combined effect was a glorious light up to the five miles. Then, if the electric light was extinguished, there was a great falling of in the effect; though after a few moments' rest to the eye it was seen that the oil lamps and reflectors were in their proper state. On the other hand, when the electric light was restored, the illumination became again perfect. Then, while both were in action, the reflectors were shaded, and the electric light left alone; but the naked eye could see no sensible diminution; nor when the reflectors were returned into effectual use could it see any sensible addition to the whole light power; though the telescope showed that the alteration in the lantern had taken place at the right time. Such was the power of the electric light that the addition or subtraction of the light of a fully effective set of reflectors, with their lamps, would not have been sensible to a mariner, however observant he might have been. Professor Faraday enumerates some points which are against, and others in favour of the light. In the first place, the simplicity of the present system is very great compared with that of the electric light; only two keepers are required to a lighthouse; they need possess no special knowledge; ordinary attention is all that is necessary; and thus failures of the light are almost impossible. In the new system a second set of men will be required to attend the engines, and there must be amongst them one or more who understand the principle and construction of the lamp in the lantern, of the magneto-electric machines, the steam engines and the condensers, and be able to make effectively the repairs necessary to the apparatus. In the next place, the expense of the new system must be large compared with that of the present system. Other objections have been made, of which Professor Faraday cannot see the force, namely, that the light is too bright—that it gives a false impression of the distance of the lighthouse—and that it blinds the eyes of the mariners to the perception of the lights on board vessels between it and them. These objections, he says, if they have any force, must be judged by mariners themselves. The points in favour of the magneto-electric light are strong and clear in relation to the increase of light. In cases where the light is from lamp-flames fed by oil, no increase of light at or near the focus or foci of the apparatus is possible beyond a certain degree, because of the size of the flames; but in the electric lamp any amount of light may be accumulated at the focus and sent abroad, at, of course, an increased expense. In consequence of the evolution of the light in so limited a focal space, it may be directed seaward, diverging either more or less, or in a vertical or horizontal direction, at pleasure, with the utmost facility. The enormous shadow under the light produced by the oil-flame burner, which absorbs and renders useless the descending rays to a very large extent, does not occur in the magneto-electric lamp; all the light proceeding in that direction is turned to account; and the optical part of the arrangement, whether dioptric or reflecting, might be very small in comparison with those in ordinary use. With reference to the final experiment now taking place at Dungeness, though Professor Faraday thinks that many changes might be made in the size, arrangement, and adjustment of the optic apparatus, he reserves these points for ranges and future consideration, aided by the instruction that will arise from the results of experience.

Iron-Making—"Blooming."—The patent blooming, recently erected at the Dowlais Ironworks, South Wales, was started on the 6th ult., and came off very successful. It consists of a series of vertical and horizontal rolls, which are placed in such a manner that the bloom on being entered in the first pair, passes through the entire train without the assistance of roughers, hookers, &c., at the rate of 300 blooms per hour. It is the invention of Mr. Charles White, of the Taff Vale Ironworks, Treforest, and is said to be one of the greatest improvements known in the ironworks for many years.

Pneumatic Despatch.—On the 24th ult. the tube for the conveyance of letters, parcels, newspapers, and packages, on the pneumatic despatch principle, and which has been carried underground between the railway clearing-house of the London and North-Western Railway in Seymour-street, Euston-square, and the North-Western District Post Office in Eversholt-street, Hampstead-road, was completed. The engine-house is a neat brick building on the London and North-Western Railway Company's Station. The engineers report to the directors that the tube will be ready for public traffic early in the present month.

The Fen Drainage.—The wind and tide of the 21st ult. made a complete wreck of Mr. Page's dam at the entrance of the Norfolk Marshland Smeeth and Fen drain. The dam had been in course of construction since the previous October, and about £3000 had been expended on it. At a meeting of the committee of the district at Lynn on the following day, it was resolved to rescind the appointment of Mr. Page as engineer, and the dam and banks have been entrusted to Mr. W. P. Harding, C.E., of Lynn, with whom a committee was appointed to co-operate.

NAVAL ENGINEERING.

Our Steam Strength.—At the distribution of Queen's Prizes and Society of Arts' Certificates, held at the Manchester Mechanics' Institution, Dr. Fairbairn, speaking on our steam strength, said:—The extent of this force in this country alone in 1859 was as nearly as follows:—In mining and metal manufactures, the steam engines employed represented the nominal power of 450,000 horses, indicating in reality 1,350,000 horses' power. In manufactures the steam engines represented a nominal power of 1,350,000, or, in reality, 4,050,000 horses' power. In steam navigation, the engines employed represented a nominal power of 850,000, or, in reality, 2,550,000 horses' power. In locomotion, the engines employed represented the nominal power of 1,000,000, or, in reality, 3,000,000, horses' power, the total nominal power being 3,650,000, or, in reality, 10,950,000 horses or about 11,000,000 horses' power, each raising thirty-three thousand pounds one foot high in one minute, or equivalent to the enormous force of raising 162,053,575 tons one foot high in one minute, or 1,620,535 tons to a height of 100 feet in the same time. This was estimated as the work done per minute three years ago, now it had increased to upwards of 12,000,000 horses' power, which might be taken as the motive power in the British isles alone. It would be interesting to know the quantity of coal consumed for the purpose of generating a force equivalent to raising the above enormous load of 9,723,214,500 tons one foot high in an hour. This would require the strength of 11,000,000 horses to accomplish in one hour, and this multiplied by five, the average consumption of coal per hour per horse power, gives 24,533 tons, or about 25,000 tons, as the rate of consumption per hour for the steam power of Great Britian and Ireland.

The "Royal Sovereign."—On the 12th ult., the bending to the required shape of the first of the armour plates for this frigate took place. The plate was brought to the necessary form in two heats. The bottom of each furnace which has been built for heating the plates, is moveable, and consists of a strong iron frame, mounted on four wheels. The top of the framework, which is covered with layers of firebrick, thus forming the bottom of the annealing furnace. On these layers of firebrick, the plate for heating was laid by the aid of ponderous cliphooks, from a beam suspended from a travelling tubular crane. The plate in position, the carriage or bottom of the furnace was drawn into the necessary heating position. The plate having been brought to a sufficient heat was withdrawn from the furnace on its carriage, and was then seized by the cliphook, and conveyed by the travelling crane over two rows of massive iron bars, each row being 4ft. apart, fixed upright on an iron bed, the rows of bars exceeding in length the length of the plate. The upper ends of these upright bars are secured by two transverse bars of great strength, and are fastened by nuts and bolts. Between these upright bars are thrust other massive bars, which have been forged to the exact curve wanted to be given to the inner surface of the armour plate. These moulded bars rest on the iron below, their ends being held securely by the lower ends of the upright bars on each side. The heated armour plate was next lowered by the crane and cliphooks upon the moulded bars, and between the rows of upright bars. Other massive bars, moulded to the same form as those underneath, were then laid on the top of the plate, with their ends projecting through the upright bars. Heavy iron wedges were driven over each end of the upper moulded bars by slung iron bars of some hundredweight each, and the armour plate gradually yielded to the strain thus brought to bear upon it.

The "Royal Oak."—The contract price paid by the Admiralty for the plates affixed to this frigate is £37 per ton. The plates have an uniform weight of four tons, making each cost £148. Taking the number required to encase the *Royal Oak* at 280, the total cost of the armour plates alone may be set down at upwards of £40,000; in addition to which, the most powerful machinery is required to bend, shape, polish, and otherwise prepare the slabs of iron before they are fit to be bolted to the vessel's side, thus raising the cost of each to nearly double its original price.

The "Meanee," 60 guns, 2591 tons, 400 horse power, finished her trials at the measured mile, off Maplin Sands, on the 13 ult., previous to her departure for the Mediterranean. The following are the results of the trial:—the ship's speed at full boiler power 9·756 knots; number of revolutions, 60½; vacuum, 25½; pressure of steam, 20; draught of water forward, 22ft. 10in.; aft, 24ft. 8in.; pitch of screw, 19ft.; diamater, 17ft. At half boiler power the average speed was 6·957 knots; vacuum, 26; pressure of steam, 20; revolutions, 60. The trial was considered to be very satisfactory.

The "Columbine," 4, screw gun vessel, 669 tons, 150-horse power, underwent her trial trip on the 16th ult., at the measured mile off Maplin Sands. The *Columbine* made six runs at the measured mile, giving a result of 9·614 knots per hour, with 102 revolutions per minute; vacuum, 23; pressure of steam, 20. During the trial there was scarcely any perceptible vibration from the working of the machinery. After the trial of speed, the steering qualities of the vessel, with the old rudder, was tried, and the results noted for comparison with a similar trial, to take place with Lumley's patent steering apparatus. The first trial was at full speed, helm starboard at an angle of 23 degrees, when the circle was made in 4 min., 26 sec., the diameter of the circle being 536ft. The second trial was from dead stop, helm starboard, at an angle of 35 degrees; the circle was made in 4 min., 30 sec.: diameter, 693ft. In the third trial at full speed, helm port, at an angle of 18 degrees, the circle was made in 5 min., 5 sec.; diameter 1718ft. Fourth, from dead stop, helm port, at an angle of 27 degress, the circle was made in 4 min., 28 sec., diameter, 693ft. In the fifth at full speed, helm starboard, at an angle of 11 degrees, the circle was made in 7 min., 48 sec. In the sixth at full speed, helm port, at an angle of 11 degrees, the circle was made in 11 min., 20 sec.

The "Lily," 200-horse power, commissioned for the North American and West India Station has made her last official trial trip. The *Lily* attained an average speed, at full boiler power of 10·087 knots per hour, pressure of steam being 19½; vacuum, 25; revolutions of engines, 80; at half boiler power the average speed was 8·466 knots; pressure of steam, 16½; vacuum, 25; revolutions, 69. The circle was made at full speed in five minutes, being equal to a rate of 10½ knots per hour. The machinery and vessel worked in an excellent manner, and the result of the trial was highly satisfactory.

Government Steam Troop Ship "Orontes."—This vessel has been launched from Messrs. Laird's yard, at Birkenhead. She is the first government troop ship, and the largest ever built on the Mersey—being 300ft. long, 44ft. 7in. broad, 32ft. deep, with a register measurement of 2811 tons. She bears a great resemblance to the *Himalaya*, the successful working of which vessel has convinced the government that troop ships specially built for the purpose are more advantageous. The *Orontes* will accommodate 1100 to 1200 soldiers, in addition to her complement of officers and crew. She is constructed of iron, is of immense strength, and will be fitted with engines of 500-horse power. The total tonnage of vessels now building in Messrs. Laird's yard is between 1700 and 1800 (including the armour-plated frigate *Agincourt*), giving employment to nearly 3000 men in the various departments. It is worthy of remark that the *Agincourt* 700 tons larger than the *Warrior*, is being built in a dry dock to avoid the risks of ordinary launching, and will be ready in twelve months.

New American Screw Ram.—A New York paper states that the *Dunderberg* is being built 378ft. long, 68 broad, 32 deep, with engines of 6000-horse power. The hull is built of wood, placed together so as to form a solid mass. The decks, sides, and floor are also solid, and of a great thickness, so much so that if the figures were given, all would be greatly surprised at the amount of wood used in the construction. This enormous wooden hull is heavily plated with rolled iron plates, which cover the entire upper portion of the vessel, and extend 6ft. below the water line. The weight of this terrible armour is not far from 1200 tons. The bow of the vessel, for 50ft. abaft the stem, is of solid wood, with no space between the sides of the vessel, this being covered with iron, forming the most gigantic ram on record, having powers of resistance unequalled in every respect. The sides of this vessel, above the water line, are 7ft. thick and of solid wood, added to which is the heavy iron plating. This vessel has two rudders, one at each end, so protected that should one become disabled from any cause, the other can be easily used. The engines will give this vessel a very high speed, so that it is presumed when she strikes a vessel she would crash through her with perfect ease. Above the main deck the build is very peculiar, but at present cannot be described. In addition to a large casemate, containing heavy broadside guns, there will be two of Ericsson's revolving turrets, each containing two 15-inch guns. The naval register puts her armament down at ten guns, but it will be much larger. The accommodation for the officers and men are, it is stated, to be of a superior kind—large, airy, and as well ventilated as an ordinary ocean steamer, yet giving to them all the necessary security in time of action. In every respect she will be one of the wonders of the age. She is intended more particularly for harbour defences, but can readily go to sea, as she possesses all the qualifications for buoyancy, &c. She is intended to defy anything else in the shape of an iron-clad.

Federal Naval Experiments.—It is stated that Captain Ericsson has devised machinery by which four men can work a gun weighing twenty tons, in a turret. Another invention has also been tried, but without the same success—a contrivance for firing a 15in. gun inside a turret. To fire it outside the turret would require a port so large that a good marksman with a rifled gun could hit it nine times out of ten. Hence the necessity for some invention by which the huge gun could belch its thunders upon the enemy from the inside of the turret without filling it with smoke or creating a concussion so great as to endanger the lives of the gunners. To this end Captain Ericsson invented a peculiarly shaped box, but which was shattered to pieces in the trial, after three shots were fired. It is taken for granted, however, that the difficulty will be overcome in time, and that the *Monitors* will then be the most formidable vessels afloat, though it remains to be seen whether they may not be run down by a ram.

The Sutlej.—The trial of this frigate took place at Portsmouth on the 5th ult., and was attended with the most satisfactory results to all concerned. The ship first steamed as far as St. Helen's Roads, when her course was steered for the measured mile in Stokes' Bay, on reaching which the required runs were made at full and half boiler power, and circles made in the ordinary manner under full steam, as follows, the screw in use being a Griffiths, with a diameter of 17ft. 6in., and a pitch of 20ft., at full boiler power:—

No. of run.	Time. h. m.	Speed of Ship.	Revolution of Engines.
1.	4 45	12·631	68
2.	5 32	10·843	69
3.	4 32	13·235	71
4.	5 55	10·140	70
5.	4 26	13·533	70
6.	6 13	9·651	70

The ship's mean speed in the six runs was 11·806 knots. Two runs followed at half-boiler power, the first giving the ship a speed of 10·876 knots with the tide; and the second against the tide, and in the face of nearly half a gale, slightly on the starboard bow, of 6·101 knots; the mean of the two being a speed of 8·488 knots. Getting the steam up again to its full pressure, the ship was next tested in making complete circles to port and starboard, and in moving the engines to signal from the deck bridge. The helm was first put to starboad with 2¾ turns of the wheel, bringing the rudder to an angle of 19 degs., when the half circle was made in 3 min, 50 sec., and the full circle in 7 min. 42 sec. With the helm to starboard, and 2½ turns of the wheel, bringing the rudder to an angle of 22½ degs., the half circle was made in 3 min. 42 sec., and the full circle in 7 min. 1 sec. Eleve n men were stationed at the wheel. At the conclusion of the circle trials the machinery of the ship was tested in its movements, in answer to the signal given from the ordinary iron rod and bevelled wheel telegraph of the upper deck bridge. From the time of moving the telegraph handle on the bridge, the engines were brought to a state of rest from full speed in 19 seconds. They were next turned astern, and full speed attained in 9 seconds; and from full speed astern to full speed ahead, only 24 seconds elapsed. The working of the engines and boilers was all that could be desired on every point. The weather was not the most desirable for developing the best steaming powers of the ship, as the wind, which was at a force of from 3 to 4 from south at the commencement of the runs at the mile, gradually increased until, as the full power trials drew to a close, it blew nearly half a gale, with the wind slightly backing to the eastward. This, of couse, had a very prejudicial effect upon the ship's speed, and especially in the two runs at half boiler power.

Naval Appointments.—The following appointments have taken place since our last. J. R. E. Ramsey, acting Second-class Assist. Engineer to the *Indus*, as supernumerary; J. Redgrave, acting Second-class Assist. Engineer, to the *Dromedary*; S. Madden, Chief Engineer to the *Indus* for the *Pelorus*; W. H. Houghton, acting Chief Engineer to the *Asia*, as supernumerary; C. A. Hobbs and R. Sampson, Chief Engineers to the *Asia*, for *Algiers* and *Arrogant*, respectively, when paid off; F. S. Turner, acting Second-class Assist. Engineer, to the *Indus*, for the *Valorous*; W. Vawdrey, acting Second-class Assist. Engineer, to the *Cumberland* for the *Conqueror*; J. Lambert and J. Horrocks, acting Assist. Engineers, to the *Niagara* and *Pylades*, respectively; W. M. Chambers, Chief Engineer, R. Winter, and A. Purvis, First-class Assist. Engineers, and J. A. Shawyer and J. Stout, Second-class Assist. Engineers, to the *Pylades*; F. Pursell, acting First class Assist. Engineer, to the *Cumberland*, for the *Spanker*; J. Runnalls, acting Second-class Assist. Engineer, to the *Indus*, as supernumerary; J. Langland, Engineer, J. B. Liddell, First-class Assist. Engineer, and J. Conolly, Second-class Assist. Engineer, to the *Shearwater*; T. Murray, Acting First-class Assist. Engineer, to the *Indus*, for the *Clinker*; R. Widdecombe, in the *Aboukir*, W. P. Ward, in the *Liffey*, J. R. Hancock, in the *Fox*, H. J. Wilson, and T. Cross, in the *Asia*, and A. Smart, in the *Pembroke*, to be First-class Assist. Engineers; J. Miller (a), in the *Mars*, J. Manhinnick, in the *Ariel*, A. J. Barton, in the *Wanderer*, and J. Phillips, in the *Clio*, to be acting First-class Assist. Engineers; S. Swift, Chief Engineer, to the *Asia*, for the *Neptune*; J. A, Barton, Chief Engineer, to the *Cumberland*, for the *Amphion*; J. Downe, Engineer, to the *Indus*, for the *Sriton*; J. Jroine, Acting Engineer, to the *Indus*, for the *Partridge*; H. G. Burr and W. Harvey, Acting Second-class Assist. Engineers, to the *Cumberland* and *Indus* respectively, as supernumeraries; C. Jeely, Chief Engineer, to the *Cumberland*, for the *Scylla*; W. Bremner, Second-class Assist. Engineer, to the *Cumberland* as supernumerary; T. Owen, Acting Second-class Assist. Engineer, to the *Indus*, for the *Prospero*.

MILITARY ENGINEERING

Armstrong and Whitworth Guns.—Some additional experiments have taken place at Shoeburyness, with 12-pounder Armstrong guns, fired against Mr. Scott Russell's target. A new form of round-fronted shot, recently produced by Sir W. Armstrong, was used, and, with the ordinary charge, penetrated much deeper than the Whitworth shot. On the 3rd ult. the target fired against by the Whitworth shells, and the timber backing of which was said to have been completely shattered by the explosion underwent an examination, and it was found that no serious injury to the timbers beyond what usually arises from the shock of firing had taken place. A fragment of one of the iron plates was driven into the backing, but the injury spread no further; and it is asserted by artillery officers present that, as an explosive missile, the Whitworth shell has thus far done no material injury to the timber backing of the target.

LONG AND SHORT PROJECTILES.—Since the ordnance stores have been filled with long lead-coated shot sufficient to last for several years—if they can be made to keep without deterioration from galvanic action—it is said to have been discovered that short shot are the proper thing. Lately projectiles weighing from 50lb. to 68lb., instead of 110lb., have been fired from the 110-pounder guns at Shoeburyness, and a velocity of from 1550ft. to 1600 ft. per second obtained by increasing the powder charges. This is, however, still below that of the 68lb. shell, which has a velocity of 1810 ft. per second, while the solid ball from the same gun has a velocity of 1580 ft. per second, with the very large windage of two-tenths of an inch—but will the fine grooving stand the strain due to the increased velocity given to the short projectile?

SOLID DRAWN GUN BARRELS.—On the 2nd ult., by the permission of the court of the company, some very interesting experiments were made at the proof-house of the Gun-makers' Company, Whitechapel, on a fowling piece and rifle barrel made by the new process of solid cold-drawing, of which Messrs. Christoph, Harding, and Hawksworth, are the patentees. By this process the metal is drawn cold by means of the hydrostatic ram, and thus a saving is effected to the extent of one-half the metal now consumed by the hot process. For instance, about 10lb. of metal is now used in making an Enfield rifle barrel, which when made weighs only about 4½lb., the remainder of the metal being consumed in the manufacture. By the present process two rifle barrels can be drawn from the same amount of metal, equally strong in every respect to those now made. The barrels tried were drawn from a new kind of cast steel and subjected to the following proofs:—

Rifle Barrel.

First proof....................	7½ drachms of powder	
	2 wads	
	1 ball af 510 grains	No effect
Second proof................	Same powder	
	2 balls..	No effect
Third proof..................	10 drachms of powder	
	3 balls..	Ditto.
Fourth proof................	15 drachms of powder	
	5 balls..	Ditto.

The fowling piece was put to the following proofs:—

First proof	10¾ drachms of powder	
	2 wads	
	One round ball of 14 to the pound.........	No effect
Second proof................	Same powder	
	2 wads	
	2 round balls..	No effect

It was then determined to burst this barrel by putting in a proof charge and two balls, then cramming the muzzle of the barrel to the extent of two inches with moist clay. The result was that the barrel burst at the bottom of the clay, only tearing off about two inches of its length, and showing no other signs of injury. A similar barrel, proved at Birmingham, only slightly bulged, with 20-drachms of powder and three balls. Several specimens were also exhibited, showing the applicability of this process to drawing hollow tubes in iron or steel of any shape, and almost any reasonable length.

NEW DEFENCES AT PORTSMOUTH.—Some hundreds of men are employed at Portsdown-hill in the construction of an important line of forts, extending from Bedhampton to Fareham, by Farlington, Parbrook, and Crookhorn, three forts forming a triangle, and connected together by galleries, parapets, and ditches, excavations only being as yet made under the first contract; and by Windmill or Widley fort, where brickwork as well as excavations are in progress; by Southwick fort, the most elevated of the whole series, and the one most immediately opposite the dockyard, and which, as well as the next at Widley is vast developing its extent and form; by Nelson fort, which is being erected at the Obelisk; and next by Fort Wallington, which crosses fire with Fort Fareham on the opposite side of the creek. Fort Wallington is a work of great strength and extent. Fort Fareham is included in this line of forts as a defence to Portsdown on the west. Widley, Southwick, and Nelson forts, which are contracted for by Messrs, Treadwell, will be supplied with water from one reservoir formed at Southwick. The six first mentioned contracts do not include barracks and other works, but the plans are complete. The revetments of all the ditches will be of chalk masonry and flint.

STEAM SHIPPING.

THE STEAMSHIP "GREAT EASTERN."—Mr. C. H. Haswell, of New York, has addressed the following letter to Messrs. Howland and Aspinwall, upon the subject of the repairs to the *Great Eastern*, rendered necessary in consequence of the last accident to this vessel:—"New York, December 3rd, 1862.—Gentlemen,—In conformity with your request, I yesterday visited the steamship *Great Eastern*, anchored off White Stone, for the purpose of examining the nature and extent of the injuries received by her in her late collision with a submerged rock, and the character of the repairs rendered necessary and in progress in consequence of that collision—and having discharged this duty, I submit the following report —Upon my arrival I examined the hull externally above water and within board, to ascertain if it gave evidence of any unresisted stress since my survey of her upon a previous voyage. Having satisfied myself upon this point, I descended from without the hull to within the coffer inclosing the rupture in her botton, and also from within the hull between the outer and inner plating, again to down to the place of rupture, being by this proceeding enabled to examine the full extent of the injuries to the bottom of the hull covered by the coffer and the character of the repairs being made thereto, and upon a full consideration of the elements presented, I am of the opinion: 1st—That the effect of the collision is restricted to a partial crushing of two of the webs and rupture of some of the outer plates of her bottom, upon the port side, and that the hull of this vessel—beyond the points of rupture, above water and within board—is in no wise injured by the collision. 2nd—That the repairs to her bottom, so far as made, have been executed in a manner to restore it to its original security as to leaks and reistance to stress, and that the design both of the method of effecting these repairs and the manner of executing them, reflect high credit to all concerned. In connection with this, it is proper to refer to the construction of the bottom of the vessel, in order that it may appear how peculiarly adapted it is to meet an injury like that which has occurred to it. Thus, the bottom is composed of an outer and inner plating of equal thickness, with an intervening space of thirty five inches, the connection between the platings consisting of thirty-two webs or keelsons running fore and aft, and thirteen athwart ships, whereby the bottom is divided into a series of apartments or cells, the communication between them being at command, and from within board by the use of man-hole plates. In the event, therefore, of the outer plating alone being ruptured, as in the present case, the inner plating will resist the admission of water within the hull, and the cellular structure of the whole will resist the admission between the platings, beyond the limits of the cells inclosing the rupture. In communicating the result of my survey to the Underwriters here, and to Lloyd's, London, I shall report her sea-worthiness—provided the repairs now in advanced progress are completed—to be of the same character as before the collision which has involved them."

THE AMERICA screw, intended for the Nordentschen-Lloyds, of Bremen, has been launched from the yard of Messrs. Caird and Co., of Greenock. She is of 2500 tons, and is the fourth vessel of the same size built by this firm for that company. The *America* is 360ft. in length, 40ft. breadth of beam, and 34ft. depth of hold. She is to be fitted with a pair of inverted cylinders, direct acting engines of 500-horse power, nominal, capable of being worked up to 1800-horse power. Messrs. Caird have besides on the stocks another steamer of the same dimensions for the Hamburgh and American Steam Packet Company, a mail steamer for the London Brighton and South Coast Railway Company, and five paddles for the home trade.

THE "ELECTRIC," screw steamer, intended to ply between Belfast and Liverpool, was recently launched from the yard of Messrs. Todd and M'Gregor, of Glasgow. Her dimensions are—length 210ft., breadth of beam 27ft. Another steamer, similar to the *Electric* and intended for the same trade, will soon be completed by Messrs. Todd and M'Gregor

THE "PALERMO," screw steamer, of 409 tons register, the property of Messrs. Florio and intended for the Sicilian and Italian trade, has been launched from the building yard of Messrs. Scott and Co., Cartsdyke. Her engines, which will be of 140 horse-power, will be supplied by the Greenock Foundry Company, The *Palermo* is nearly similar in size to the *Etna* and *Campidoglio*, recently launched by the same firm and for the same owners.

THE "UNDINE YACHT."—This handsomely fitted-up steamer, belonging to the Duke of Sutherland, recently fitted with engines by Messrs. Jas. Watt and Co., made a trial trip down the river on the 1st ult., for the purpose of testing her speed by the measured mile. The following is the result as registered by Troddam's tables:—1st trip in 5 min., 35 sec.; 2nd in 5 min., 38 sec.; 3rd in 4 min., 46 sec.; 4th in 4min., 49 sec.; 5th in 6 min,, 36 sec.; 7th in 7 min., 4 sec.

TELEGRAPHIC ENGINEERING.

TELEGRAPH FEAT.—The wonderful feat of writing by telegraph direct through a continuous line of 3500 miles, has been achieved in the United States. Between 4 and 5 P.M., a news message was sent to San Francisco, to which, a few minutes afterwards, a return message was received, dated San Francisco, Nov. 6th, 2¼ P.M., was answered at 2 P.M., or three hours before it was sent, in the usual order of time. The difference in time between the two cities is three hours and fourteen minutes.

TELEGRAPH TO AMERICA.—Another attempt is being made to raise the necessary capital for testing the great experiment of uniting this country with America by means of submarine telegraph. It appears, also, that the directors have received a tender from Messrs. Glass, Elliott, and Co., who agree to make and lay a cable from Ireland to Newfoundland on conditions peculiarly favourable to the company.

SUBMARINE CABLES.—The Gutta Percha Company have recently published a list, which shows that fifty-one submarine cables have been undertaken between 1851 and 1862, and that the entire number, with the exception of seven, are at present in good working order.

THE TELEGRAPH TO INDIA COMPANY.—At a meeting recently held of this company the report was unanimously adopted. The Indian Government have determined to construct a line from Bagdad to Kurrachee. The Company's line between Jubal and Alexandria continues to work most satisfactorily. The Indian Government refused the application for a guarantee to enable the Company to establish a new Red Sea line. The directors, therefore, recommend the Company to continue to work the land line in Egypt, and the cable between Suez and Jubal, retaining the firman's instruments and other property in Egypt, as in the event ot the Bagdad line proving inadequate to the requirements, or from any other cause which shall indicate the need of an alternate means of communication, the company would no doubt receive the cordial support of Her Majesty's Government and of the public in continuing the line. The 200 miles of cable which was expected shortly to arrive will be disposed of at once.

RAILWAYS.

RAILWAY CHAIRS.—Mr. Antonio Gabrielli, of Turin, proposes an improved wrought-iron chair for securing rails. The chair is composed of two-wrought iron plates, one overlying the other. The under plate is made rectangular, and forms the base of the chair, and the upper plate, which is smaller, lies across it diagonally, but so that its extremeties extend to the ends of the base plate. These plates are connected together by a central bolt, which forms a pivot far them to turn on. The central bolt is driven into the wooden sleeper. The jaws of the chair are formed by turning up portions of the sides of the two plates, Iron clamping pieces are used between the rail and chair.

IRON RAILWAY CARRIAGES.—The Pennsylvania Railroad Company are having iron cars constructed for use on their road. It is supposed that they will be much lighter and stronger than wooden cars, last much longer, and be much more secure from accident.

RAILWAY ACCIDENTS.

ACCIDENT ON THE GREAT EASTERN RAILWAY.—A serious accident on the morning of the 7th ult., took place on the Great Eastern Railway, by which considerable damage was inflicted on the permanent way and rolling stock. The train which leaves Hertford at 1 a.m., and is due at Shoreditch at 9.30 a.m., had scarcely got upon the main line when the engine left the rails, carrying with it the tender and several of the carriages. All the up-traffic was interrupted for a long time. To prevent any collision between the disabled train and the express from Norwich, which was due in about half-an-hour or twenty minutes, men were sent forward with danger signals, at the sight of which the driver of the express promptly brought his train to a standstill.

FALL OF A RAILWAY TUNNEL.—Twelve or fifteen yards of the end of a tunnel at Oakenshaw, on the Cleckheaton branch of the Lancashire and Yorkshire Railway, fell on the morning of the 23rd ult., completely blocking up the passage. A mail train from Mirfield, which should have reached Bradford at a quarter before six in the morning, ran into the midst of the rubbish. The engine was firmly embedded, but the passenger carriages were soon backed out. There was no loss of life, or other serious personal injury. A common road crossed the portion of the tunnel which fell in.

COLLISION ON THE GREAT NORTHERN RAILWAY.—A collision, involving serious injury to several passengers, and a great loss of property, happened on the afternoon of the 24th ult., at the Barnet Station of the Great Northern Railway. According to the particulars, it appears that about four o'clock on the above afternoon, a coal train was being shunted out of the siding on to the main line, but what precautions were taken to protect the road while this work was being performed by putting on the auxiliary signal has not transpired. It would seem that the shunting was going on when the up-express train from the north, due at King's-cross about a quarter-past four, was heard coming up at its usual rate of speed, not having to stop at the station. The obstruction was observed by the driver of the engine, but the distance was not sufficient to enable him to bring up before dashing into the coal waggons. To add to the difficulties, there is a descent in the line approaching Barnet from Potter's Bar of 1 in 200, and being Christmas Eve the train was unusually heavy. The shock of the collision is described as having been very great. The coal waggons were thrown high over each other across the line in great confusion, bringing down a foot-bridge erected over the railway, and ploughing up the permanent way. The speed of the passenger train had been somewhat reduced, but the force with which it came in contact with the coal waggons, caused the engine and tender to leave the metals, occasioning an alarming crash among the carriages and serious injury to several of the passengers. As the coal waggons were thrown over in such a way as to entirely block up the line, the most prompt measures were taken to warn the approaching up and down trains. Gangs of labourers were set to work to clear the road, but it was some hours ere the traffic could be resumed, occasioning the greatest inconvenience to the travellers leaving King's-cross and those bound to London.

Accident near Hereford.—On the morning of the 25th ult., an accident occurred on the Merthyr and Brecon railway, by which one life was lost and several persons seriously injured, some of whom were not expected to recover. It appears that several workmen hurriedly got into some empty trucks at the commencement of a steep incline, without attending to the break. The waggons started off down the incline at great speed; the foremost was thrown off the rails, and the others coming along, a concussion ensued, and the whole were shattered to pieces, the occupants being thrown about in all directions.

BOILER EXPLOSIONS.

Fatal Boiler Explosion at Oldham.—On the 16th ult., a serious boiler explosion took place at Messrs. Evans, Barker, and Co.'s Hartford Colliery, Lyon Dam, Oldham. A man, who was employed by the engineer to do "little jobs" for him, such as clearing away the ashes from about the boiler furnace, was blown down by the force of the shock, and covered by the *debris* of the shed. The end of the boiler was driven completely out, and the furnace door torn off, as well as the brickwork destroyed.

Boiler Explosion.—On the 16th ult., an explosion occurred at Carn Brea Mine, by the boiler attached to the stamps-engine bursting with great violence. One man, carpenter of the nine stamps, was killed, and several others were severely injured. Carn Brea Mine is the property of a company, and is one of the most extensive, as well as productive, tin and copper mines in the county. It has no less than fourteen large engines connected with it, rearing their immense shafts and flywheels over an extended district. One of these engines is known as the stamps engine; it is of great power, being 32 inches in the cylinder. It is worked by means of four horizontal boilers, placed side by side. It was the most easterly of these which exploded about half-past eight o'clock, in the morning, with a noise so great that it was heard all over the neighbourhood.

Boiler Explosion near Baxenden.—On the 19th ult., a boiler explosion occurred about half-past three in the afternoon, at the small factory occupied by Hargreaves and Bateson, Rising Bridge, near Baxenden, by which three boys lost their lives. The boys were playing in the boiler-house when the explosion took place, and by all appearances they were scalded to death. The cause of the explosion has been attributed to the fact that the under part of the boiler had collapsed, and that the steam had forced its way out by the flue.

Boiler Explosion at Masborough.—On the morning of the 3rd ult., an explosion of a boiler took place at Messrs. Beatson and Co.'s Midland Ironworks, Masborough, near Sheffield, by which seven lives were lost and a number of persons seriously injured, and also a vast amount of injury done to property. The rolling mill occupied a large space in the centre of the works, and it was in this part that the calamity took place. Several boilers, of various dimensions, were fixed in the mill, to furnish the power necessary to work the large number of rolls that are in use. One of these boilers, nearly the largest in the place, was embedded midway between two smaller ones, at about 80 yards from the entrance gate. Behind the boiler, looking westward, was a large space unroofed, occupied by vast heaps of refuse. Beyond these was the boundary of the works on that side—a large green field leading to the Fern, the residence of Mr. Beatson. Eastward, the space was occupied by a large number of puddling furnaces, rolls, and engines, the machinery attached to the latter being of the most ponderous description. The roof of the shed was partly sheet iron and partly slate, and the supports were wooden and iron beams, crossed upon very large iron pillars. Near the boiler were two enormous chimneys, into which the flues from the several of the boilers and furnaces were conducted. A few minutes after seven o'clock in the morning, there were about 150 men and boys employed in the shed, when a loud report was heard, the large boiler was launched forward into the mill, and in an instant the whole place was in ruins. The two huge tubes of the boiler were projected with immense force to the rear of the premises, on to the open space mentioned above, being accompanied in their flight by showers of red-hot bricks from the bed of the boiler, slates and sheets of iron from the roof of the shed, and other portions of the *debris* which covered the whole space around. The boiler itself was launched forward with inconceivable force, right into the body of the rolling mill. Before this missile everything went down like so many reeds. The supports of the roof were broken—solid iron columns of 12in. or 14in. thickness snapping short off, as if they had been made of glass. An immense fly-wheel of solid iron, the metal being the thickness of a man's body, was broken in two places, and a cog-wheel of even larger size was also instantaneously snapped asunder by the force of the blow. The exterior of the mill also bore numerous and serious traces of the force of the explosion and the extent of the destruction. One of the mill chimneys, a solid structure of 130 feet high, was "scarred" from the bottom to the summit with the marks of the blows it had received from the bricks and fragments of iron and machinery, which were shot up from below. The damage to the works is estimated at £3,000, but a much greater loss will be occasioned by the stoppage during the winter months.

Boiler Explosion near Alnwick.—An accident recently occurred at Rock Moor House, a farmstead in Northumberland, and situated near Alnwick, by the explosion of a boiler attached to a thrashing machine. The explosion took place during the dinner-hour, and when nearly twenty persons were warming themselves at the furnace. Six were killed on the spot, and others fatally hurt.

The Manchester Association for the Prevention of Steam Boiler Explosions.—At the ordinary monthly meeting of the Executive Committee of this Association, held on November 25th, 1862, the Chief Engineer presented his monthly report, of which the following is an abstract:—"During the past month there have been examined 365 engines and 547 boilers. Of the latter, 8 have been examined internally, 60 thoroughly, and 479 externally, in which the following defects have been found:—Fracture, 5 (1 dangerous); corrosion, 38 (3 dangerous); safety-valves out of order, 13; water gauges ditto, 31; pressure guages ditto, 9; feed apparatus ditto, 6; blow-off cocks ditto, 47 (1 dangerous); fusible plugs ditto, 3; furnaces out of shape, 6 (2 dangerous); blistered plates, 3; deficiency of water, 1. Total, 162 (7 dangerous). Boilers without glass water gauges, 10; without pressure gauges, 2; without blow-off cocks, 38; without back pressure valves, 78. An explosion has occurred this month to the boiler of a first-class passenger locomotive engine, by which three persons were killed and others injured. It was considered to be perfectly safe, had been on duty the previous day, and was being cleaned ready for work at the moment the explosion occurred. It will be remembered that reference was made in the July, 1861, report, to another explosion of a locomotive boiler, which took place while the train was running; and since that time three others have occurred in additon to the one first alluded to, thus making five during that period with this class of boiler. The cause of explosion in four of these cases proved to be thinning of the plates from internal corrosion. I have only had an opportunity of examining the plates of one of these exploded boilers, but from official reports, it appears that the corrosive action had developed itself in a very similar manner in each instance, which in the one personally examined was as follows:—The corrosion had eaten grooves or furrows parallel with and close to the edge of the overlaps of the plates, at some of the longitudinal seams of rivets; the furrows being on the outer plates of the overlap, while the deepest one, and that from which the explosion had sprung, was situated nearly midway between the smoke box and fire box. This furrowing action will be at once recognised by those who have been in the habit of observing the influence of wear upon the ordinary internally fired double-flued boiler, in general use in Lancashire. In this description of boiler the furrow is found on the inner surface, both of the front and back end-plates, but more especially at the front, and lies close to the edge of the internal flue angle-iron, which it partially encircles; the furrow being deepest at the crown, and gradually dying out in about six or nine inches on each side. It is sometimes found in the root of the angle-iron itself; the choice of position between the plate and angle-iron, apparently depending upon their comparative power of resistance. When the plate of the furnace-tube is flanged, the furrow more frequently occurs at the springing of the flange than at the end-plate. Furrowing also is very commonly found at the transverse seams of rivets at the underside of boilers; the furrows in these cases being immediately at the edges of the overlaps, and most frequently on the external surface of the plates, but sometimes on the internal. This action is more severe in long boilers than in short ones, and at the middle of their length rather than at their ends. It is seldom, if ever developed at the longitudinal seams of these boilers, except where leakage takes place, and is then found to be most severe when the objectionable plan of construction is adopted, of placing the seams of rivets in one continuous line from one end of the boiler to the other. Such are some of the manifestations of furrowing constantly met with in the boilers under the inspection of this Association, and it may be interesting to attempt to trace the cause. Furrowing appears to be the result of corrosive and mechanical action combined. The mechanical action, such as an alternate buckling of the plates, strains and frets them, and thus renders them more susceptible to the influence of corrosion than the parts at rest. Where these furrows are internal, the corrosive element is furnished by the water, which is rarely, if ever, free from acidity; and when the furrows are found externally in the flues, as explained above, the corrosion may perhaps be attributed to the influence of the gases. The cause of the buckling action varies according to the position in which it occurs. In the stationary boilers above referred to, when found in the front end plate, it may be ascribed to the alternate elongation of the internal flues, more especially at the furnace end; and, when at the bottom of the external shell, to the unequal expansion of the plates consequent upon the different strata of temperature in the water. The temperature of these strata varies with the distance from the bottom of the boiler, in proof of which it may be stated that it is frequently found that while the water is boiling on the surface, that, at the bottom of the boiler it will not scald the band. Those boilers are most conducive to this inequality of temperature which have a defective circulation of water, are so set that the last heat from the fires passes beneath them, and fed with comparative cold water introduced at the bottom. It will be readily seen how these varying temperatures induce unequal expansion of the plates, and thus put upon the seams of rivets most irregular and severe strains. In this way, it is thought that the buckling action is produced, which results in furrowing at the bottom of stationary boilers. In locomotive boilers, the buckling at the longitudinal seams, in the cylindrical portion of the shell, arises from its not being of true circular form in the vicinity of the overlaps. The tendency of the internal steam pressure is to correct this, and to induce a true circular form, and thus a cross strain, which may be correctly termed a 'girder strain,' is put upon the plates at a short distance on each side of the line of rivets; from this a change of shape ensues, which constantly varies with the pressure of steam. The position of the furrows is found to be that of greatest elasticity, being midway between the fixed ends of the fire box and smoke box, just where the buckling action would have most play. It will at once be seen that the thicker the plates, the greater the leverage of the girder action, and thus to thicken their edges is only to aggravate the evil. The true circular shape may be maintained, as far as appearance is concerned, by substituting a butt-strip for the overlap, but this, from its one-sidedness, will not prevent the girder action, and, indeed, tends to make two furrows instead of one. Were an inner as well as an outer butt-strip introduced, the parts would be in equilibrio, and the strain then passing through the centre of the plates, they would be subjected to their legitimate tensile strain only, and the buckling action in question set at rest."

ACCIDENTS TO MINES, MACHINERY, &c.

Colliery Explosion near Barnsley.—On the 8th ult., shortly before eleven o'clock, an explosion of fire damp took place at the Edmund's Main Colliery, which was attended with a very serious loss of life. The colliery, which is about 180 yards deep, and in which the Barnsley bed of coal has been principally worked, has been hitherto nearly free from accidents involving the loss of life, the proprietors, Messrs. Bartholomew, Tyas, Mitchell, and Co., having adopted every means for the safety of the men. At the time stated the men in the pit, numbering close upon 300, were startled by an explosion of fire damp, which caused those near the pit bottom to at once make to that spot for safety; those in the advanced levels, some 1400 or 1600 yards distant, were unable to reach it in consequence of the gas. The men at the top were soon made acquainted with the state of affairs by the quantity of coal and rubbish thrown up out of the cupola by the explosion. Assistance was promptly obtained, and as the news reached the other collieries in the neighbourhood the men at once ceased working and rushed to the scene of the catastrophe. Plenty volunteered to descend and rescue, if possible, the men below. In this they were so far successful that in a short time some 40 or 50 were brought to the pit mouth, about 20 of whom were burnt severely, some fatally. The bottom steward also went down, and was obliged to be left by the party he went with, having evidently penetrated too far into the workings and been overcome by the sulphur. Shortly after two o'clock it was announced that nothing more could be done until bratticing was fixed and the air-course was cleared. An investigation made by several mining engineers showed that there was no hope of rescuing the men, of whom there were supposed to be 53 in the pit. Preparations were then at once made to let the water from the canal flow into the pit, so as to extinquish the flames.

GAS SUPPLY.

Gaslight in Railway Trains.—The system of lighting railway carriages with gas, according to Newall's patent has been introduced upon the Scottish Central Railway. The first gas-lit train left Edinburgh on Monday evening, the 8th ult., for Perth, the whole of the carriages being brilliantly lighted by means of pipes (with expanding couplings carried from roof to roof) communicating with the reservoir placed in a specially-constructed compartment of the guard's break-van. Throughout the journey the lights remained perfectly steady and clear, and the passengers were much gratified with the successful introduction of this vastly superior method of illumination. Should the present trial be satisfactory, it is expected that the system will be extended to the other night trains on the line, and probably introduced on the neighbouring railways.

Atmospheric Gas.—The apparatus by which the atmospheric gas, as it is termed, is manufactured is stated to be very simple. A carburator saturates atmospheric air (which may be forced through it by any means, provided a regular supply be kept up) with an inflammable vapour, and the same result would probably ensue whether benzoine, naphtha, or any similar liquid were used. The apparatus consists of two chambers, the upper containing the principle body of liquid, and the lower a smaller quantity to saturate the air with. The liquid in the lower chamber is kept at an uniform height by a tube and valve, or other means. The lower chamber is completely filled with wicks, which are kept saturated by capillary attraction. The air passes through these wicks, and not through the liquid, and licks up so much of the inflammable vapours as to become capable of ignition.

Gas Lighting in Paris.—Several landlords in Paris have recently assumed a right to prohibit their tenants from using gas, not only in the upper part of the houses, but in the shops on the ground floor. The Court of Cessation has recently decided that the custom of lighting by gas having become almost universal, every landlord must be taken to have consented to its use in the absence of any express stipulation to the contrary.

The Illuminating Power of City Gas.—In the report presented by Dr. Letheby on the illuminating power of the gas supplied to the city of London during the Autumn quarter, by the Great Central Gas Company, the Chartered, and Commercial gas companies, the following is found. That the mean illuminating power of the Great Central gas was equal to 13·34 sperm candles of the standard quality, and that of the Chartered to 13·78 candles, and that of the commercial to 13·02. The weekly average of the Great Central had ranged 12·69 to 14·93, and that of the Commercial from 12·41 to 13·85. The difference on the mean illuminating power of the Great Central gas at the two places where it has been tested, namely, at Finsbury Square and the London Hospital, which are nearly two miles apart, differed only to the extent of 0·45 of a candle, and as the largest average (13·55) was at Finsbury Square, it was manifest that the difference was accidental. These results indicate that the gas supplied in the city by the three companies has not, during any week, been below the standard quality, and that the quarterly averages have been from 8·5 to 0·15 per cent. above it. The former is the excess of the Commercial average, and the latter of the Chartered; that of the Great Central having been 13 per cent. over the standard.

Inflammable Gas Air.—Mr. S. E. Turner, of Birkenhead, has patented an invention which relates to an apparatus for burning a mixture of inflammable gas and air, now in use, wherein the inflammable gas escapes from a jet placed inside a cylinder open at the bottom, and covered at the top with a diaphragm of wire guage, or finely perforated plate, so that atmospheric air enters the bottom of the cylinder, and, mixing with the inflammable gas issuing from the jet, assists the combustion of the same, which takes place on the top of the diaphragm. To render the combustion in such an apparatus more perfect, one or more metal tubes are introduced into the bottom cylinders wherein the mixture of the gas and air takes place; such tubes are open at the bottom, and pass up through the gauze into the combustion chamber. By this means the atmospheric air is used in a highly heated state, and the combustion, adds the specification, is much more nearly perfect.

The Carburation of Gas.—The following is an outline of the specification drawn up by Dr. Letheby for the quality of the naptha to be supplied to the carburators (nearly 2000 in number) of the City lamps. The particulars of the specification have been arrived at by a long series of experiments with naphthas of different densities and boiling points: The naphtha must be colourness, and of a gravity not less than 830, nor greater than 860. When placed in a distillation apparatus in a bath of oil, and having a thermometer placed in the naptha, it must begin to distil at a temperature not higher than 110° C. (230° F.), and must yield 70 per cent. of volatile naptha at from 110° C. to 130° C. (266° F.), and 20 per cent. between 130° C. and 150° C. (302° F.). This is expected to leave but little residuum, and to give continuously 8 grains of hydrocarbon to each cubic foot of gas, and thus raise the illuminating power of the gas about 60 per cent. over that unnaphthalised.

Report on Gas Lamps in the City of London.—The engineer and officer of health to the City Sewers Commissioners, have reported to the commissioners on the subject of gas consumption in the street lamps, including the question of meters and of carburation. The result is, that both light and economy would be promoted by the use of a meter to every street lamp, notwithstanding the probable expense of renting meters, and that carburation is also an improvement where naphtha of good quality and in sufficient quantity is used. The United Kingdom Carburating Gas Company, whose patent process has been used, state that it produces equal light with half the ordinary consumption of gas. The reporters, however, find this to be above the actual average, but they still speak of a saving of from 25 to 75 per cent., and of £1 per lamp per annum.

The York Gas Company, between whom and the public and Corporation, there has been much dissatisfaction on account of the high prices charged, have agreed to reduce their charge for public lamps from 4s. 9d. to 3s. 9d. per 1000 cubic feet, the price to include all other charges. To private consumers the charge is to be—present year: 3s. 9d.; and from and after January, 1864, 3s. 6d. per 1000 cubic feet, instead of 4s. 6d. hitherto paid.

MINES, METALLURGY, &c.

Iron Ore.—Particulars have been recently given with respect to the pig iron and coal production of the United Kingdom. It may now be added that Mr. Hunt estimates the amount of the iron ore made available in 1861 at 7,215,518 tons, of the computed value of £2,302,371. Of this amount Cornwall contributed 26,262 tons, of the value of £8372; Devonshire, 5399 tons, of the value of £2159; Somersetshire, 32,763 tons, of the value of £16,381; Gloucestershire, 100,419 tons, of the value of £45,189; Wiltshire, 55,779 tons, of the value of £26,493; Hampshire, 4007 tons, of the value of £1706; Oxfordshire, 5600 tons, of the value of £2100; Northamptonshire, 113,139 tons, of the value of £28,534; Lincolnshire, 33,559 tons, of the value of £13,403; Warwickshire, 15,250 tons, of the value of £4000; North Staffordshire, 499,195 tons, of the value of £174,711; South Staffordshire, 727,500 tons, of the value of £227,342; Shropshire, 223,400 tons, of the value of £48,403; Derbyshire, 396,520 tons, of the value of £99,130; the North Riding of Yorkshire, 1,130,760 tons, of the value of £169,368; the West Riding of Yorkshire, 235,500 tons, of the value of £58,875; Lancashire, 519,180 tons, of the value of £259,500; Cumberland, 472,195 tons, of the value of £259,680; Northumberland and Durham, 10,750 tons, of the value of £3000; North Wales, 86,500 tons, of the value of £22,425; South Wales, 542,705 tons, of the value of £172,287; Scotland, 1,975,000 tons, of the value of £658,333; Ireland, 165 tons, of the value of £66; and the Isle of Man, 967 tons, of the value of £816. Ore, although scarce in the Isle of Man, would thus seem to be of extremely high quality.

Coal.—Mr. Hunt estimates that 83,635,214 tons of coal were raised in the United Kingdom during 1861. Of this amount Durham and Northumberland, with 274 collieries, contributed 19,144,965 tons; Cumberland, with 28 collieries, 1,255,644 tons; Yorkshire, with 397 collieries, 9,374,600 tons; Derbyshire and Nottinghamshire, with 180 collieries, 5,116,319 tons; Leicestershire, with 11 collieries, 740,000 tons; Warwickshire, with 16 collieries, 647,000 tons; Staffordshire and Worcestershire, with 580 collieries, 7,253,750 tons; Lancashire, with 373 collieries, 12,195,500 tons; Cheshire, with 39 collieries, 801,570 tons; Shropshire, with 66 collieries, 829,750 tons; Gloucestershire, Somersetshire, and Devonshire, with 112 collieries, 6,514,025 tons; Wales, with 398 collieries, 8,561,021 tons; Scotland, with 424 collieries, 11,081,000 tons; and Ireland, with 46 collieries; 123,070 tons. The coal production of the empire appears to have largely increased during the last eight years. Thus in 1854, with 2,397 collieries worked, 64,661,401 tons of coal were raised; in 1855, with 2,613 collieries, 64,453,079 tons; in 1856, with 2,829 collieries, 66,645,450 tons; in 1857, with 2,867 collieries, 65,394,707 tons; in 1858, with 2,958 collieries, 65,008 649 tons; in 1859, with 2,949 collieries, 71,979,765 tons; in 1860, with 3,009 collieries, 84,042,698 tons; and last year, with 3,052 collieries, 83,635,214 tons. Of this vast quantity, only 7,560,758 tons of coal, 286,150 tons of coke, and 79,717 tons of patent fuel were exported, the remainder being absorbed at home. France was, in 1861, our best customer for coal, having taken 1,436,160 tons (in 1862 the exports in the same direction have been somewhat reduced, in consequence of the use of French coal for the Imperial navy); Denmark came next, with 542,567 tons; Hamburg, 514,427 tons; Prussia, 439,096 tons; Italy, 417,629 tons, Spain and the Canary Islands, 403,238 tons; America (Atlantic ports), 349,931 tons; Russia (northern ports), 342,513 tons; the foreign West Indies, 262,932 tons; Holland, 262,868 tons; Sweden, 214,004 tons; British India (continental territories), 199,069 tons; Turkey, 174,686 tons; the British North American colonies, 165,824 tons; Brazil, 157,281 tons; Norway, 135,221 tons; the British West Indies, 127,768 tons; Malta, 115,731 tons; Portugal, the Azores, and Madeira, 108,794 tons; and Hanover, 100,312 tons. Our other foreign customers took less than 100,000 tons each.

Mining by Machinery.—An improved mining machine is at present at work at the Claxton Quarry, Gateshead, and appears to give complete satisfaction. It is manufactured by Messrs. Hawks, Crawshay, and Co., and said to be the invention of Captain Penrice, by whom it was submitted to the English and French Governments during the Russian war. The ventilation is kept up by suction, through a pipe, outwards instead of by the ordinary method of forcing the air in. A tube is carried along the top of the tunnel, at the head of which a partial vacuum is formed, the vacuum being refilled by the air which rushes into the tunnel. This tube is the chimney of the boiler, and the exhaust steam of the engine being driven into it, the ventilation is increased by this means also. The ash-pan is closed, an air-pipe is carried forward from it to the head of the bore, so that all the air drawn through the furnace by the exhaust of the engine and the suction-fan is taken direct from the inner end of the funnel, where it is replaced by fresh air from the exterior, and a very strong draught is created. The heat from the boiler is confined by means of water-tanks, which cover the surface of the boiler; and as there is a thick lining of felt between the boiler and the water-tanks, the constant supply does not at all interfere with the generation of steam. In Captain Peurice's machine a number of large chisels are inserted in the radial arms of a circular piece of metal, which is made to revolve, and at the same time to strike the face of the rock very rapidly. The advantage of the rotary motion is that the chisels are always chipping against an edge as they revolve. These blows are delivered at the rate of from 400 to 500 a minute, by a mass exceeding 9 tons in weight. The debris falls to the ground, and is carried off beneath by rakes attached to an endless chain; and so admirable is the action of the machine that 12ft. of tunnel can be, and has been, made in 33 hours. Under these circumstances there certainly appears to be full justification for the statement that the machine is constructed upon sound principles, and is of great practical value. It has been found that the ventilation is so perfect that with a boiler in the place, working at 120lbs. to the inch, the temperature did not exceed 60° Fahr., so that there could be no inconvenience from excessive heat. A company under the name of the Patent Steam Tunnelling and Mining Machine Company has been formed for developing this invention.

Melting Steel in Large Masses.—Mr. Alfred Indre, of Paris, has discovered that by covering steel with bottle glass, or the slag of a charcoal smelting furnace, it may be melted in a reverberatory furnace easily and rapidly, and without losing any of its qualities. Two tons may be melted at once in the same furnace. Although the furnace in which the experiments were tried was defective, it was found that, in consequence of crucibles being dispensed with, and less fuel being required, a considerable economy was effected.

Diamonds used for Boring Hard Rocks.—An instrument for this purpose is now being employed in France, made out of a tube furnished with a circular cutter of rough diamonds. It is caused to revolve, and as it enters into the stone, the cutter scoops out a cylinder, which is afterwards easily taken out of the tube. Holes in hard granite for blasting purposes, 47 millimetres in diameter, and from 1·10 metres to 1·20 metres deep, are thereby bored in one hour. This would require two days' work in the ordinary way. The diamonds, when examined through a magnifying glass, do not appear at all injured.

New Gun Metal.—The following is given by a correspondent of one of our contemporaries as the composition and mode of forming the new alloy which has been proposed in Austria as a substitute for ordinary gun metal, consisting of copper and tin. It is composed of 60 parts of copper, from 34 to 44 of spelter, from 2 to 4 of iron, and from 1 to 2 parts of tin. The iron, which must be wrought-iron, is put at the bottom of a crucible with the copper upon it, and the whole exposed to a very high temperature. The tin is then added, and afterwards the spelter. The metal is stirred, left for a minute or two, stirred again, and afterwards cast. A 12-pounder gun made of this alloy, was heavily charged with powder, rammed full of sand, plugged at the muzzle with a piece of iron, and in this state fired. All the gas resulting from the ignition of the powder escaped through the touch-hole; and not only was the gun found to be uninjured, but on careful examination not the smallest alteration in its internal diameter could be detected.

Consolidating Cast-Steel.—Mr. J. M. Rowan, of Glasgow, proposes to consolidate cast-steel, or metal produced by the pneumatic process, by compressing it whilst still liquid or nearly so, whereby it is rendered much better adapted for subsequent processes.

Aluminium Bronze.—We had occasion in our last issue, when speaking of aluminium to refer to the various articles manufactured in this metal by Messrs. Reid and Sons, of Newcastle. This firm also use a metal designated aluminium bronze, and which may contain different per centages of aluminium. It being found that a very small proportion of aluminium, added to copper, produces a compound metal of great hardness, one specimen we have seen containing 90 per cent. copper, and 10 per cent. aluminium, was so hard that the file hardly makes any impression, whatever, on it. Indeed, it would appear that there should be no difficulty in manufacturing engineering machinery and tools of this metal. A pair of scissors manufactured in this compound metal have, we understand, been found, to cut quite as well as scissors made of steel.

APPLIED CHEMISTRY.

On Chloroformic Solution of Gutta Percha, by William Hodgson, Jr.—Take of gutta percha, in small slices, an ounce and a-half; chloroform, twelve fluid ounces; carbonate of lead, in fine powder, two ounces. To eight fluid ounces of the chloroform contained in a bottle, add the gutta percha, and shake occassionally till it is dissolved, then add the carbonate of lead, previously mixed smoothly with the remainder of the chloroform, and, having shaken the whole thoroughly together several times, at intervals of half-an-hour, set the mixture aside, and let it stand for ten days, or until the insoluble matter has subsided, and the solution has become limpid, and either colourless or of a slight straw colour. Lastly, decant, and keep the solution in a glass stopped bottle.

Thallium.—On this new metal the Academy of Sciences has received a second communication from M. Lamy, from which it appears that if the discoverer, Mr. Crooks, at first discovered it to be a non-metallic substance he was not far wrong. At least, M. Lamy finds it wanting in one of the chief properties of metals, viz., the power of conducting electricity and heat, since the effects of induction developed in the metal are of but slight intensity when the circuit of the pole is successively closed and broken. Thallium and its compounds are diamagnetic; its density is enormous, being 11·862, or 0·5 more than lead; its specific heat is 0·0325; its chemical equivalent, 204. The aqueous solutions of its salts are not precipated either by alkalies or alkaline carbonates, or by the yellow and red ferrocyanides of potash. But hydrochloric acid produces on all but insoluble white precipitate, which is a protochloride; iodide of potassium, chloride of platinum, and chromate of potash yield yellow and insoluble precipitates. Zinc precipitates thallium from its solutions, especially from that of the sulphate, in brilliant lumine variously ramified. Thallium combines with oxygen in two different proportions. The protoxide is soluble in water, to which it imparts alkaline and caustic properties. It is yellow if hydrated, and black in the contrary case; if heated in concentrated alcohol, a part of it is dissolved, and a curious compound produced, called thallic alcohol by M. Lamy. It is a limpid oil, containing great refractive power and a caustic taste. Its density is 3·50. The black peroxide is obtained by burning thallium in oxygen; it is composed of one equivalent of metal and three of oxygen. It is insoluble and melts at a bright red heat, losing some of its oxygen. The carbonate of thallium is soluble in water, and crystallizes in long prismatic needles of a greyish yellow. The nitrate is the most soluble salt of this metal. There are three chlorides and one sesqui-chloride, crystallizing in fine yellow hexagonal plates. Its density is 5·00.

LIST OF APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF "THE ARTIZAN."

DATED NOVEMBER 21st, 1862.

3125 W. Sinnock—Treatment and combination of fibrous materials.
3126 C. Hadfield & W. A. Attkins—Dressing bricks and tiles.
3127 J. Townsend—Damping and preserving vegetable substances and other textile materials and fabrics.
3128 J. R. Napier & W. J. M. Rankine—Boilers, and valvular mechanism for steam engines.
3129 W. E. Gedge—Elastic fastenings for gloves.
3130 D. Saul—Crinoline skirts.
3131 J. Stuart—Extracting the fibre from zostera marina and other aquatic vegetable productions.
3132 T. Walker—Utilizing sewage matter.
3133 C. Wagner—Strengthening, securing, and rendering mare durable the soles of boots and shoes.
3134 R. W. Swinburne—Soda.
3135 G. G. Sanderson—Armour for fortifications and floating and other batteries.
3136 J. Taylor, jun.—Tiles or moulded blocks for building purposes.
3137 C. A. Ortb—Apparatus for obtaining and applying motive power.
3138 S. & C. Deacon—Tops, caps, and windguards for chimnies.
3139 A. Sutton—Time indicator for public vehicles and other uses.

DATED NOVEMBER 22nd, 1862.

3140 W. E. Gedge—Elliptical compass.
3141 W. E. Nethersole & C. Buckland—Safety signals for fire-arm practice.
3142 M. Mishores—Handles for umbrella, parasol, or other like sticks from soft canes.
3143 C. de Bergue—Metal reeds for weaving.
3144 C. Powell—Watches.
3145 W. Clark—Caudle lamps
3146 A. V. Newton—Cotton corks.
3147 J. Webster—Burners and blow pipes.

DATED NOVEMBER 24th, 1862.

3148 T. J. Searle—Raising and forcing water.
3149 J. B. Howell—Armour and other plates, and shot and shell.
3150 W. Clark—Obtaining a vacuum or partial vacuum, as applied in the manufacture of paper.
3151 R. & W. Hawthorn—Pump valves
3152 J. Barclay—Rollers to be used in machinery for printing textile materials and fabrics, and drying and finishing the same.
3153 J. H. Johnson—Burnishing metal surfaces.
3154 E. Leigh—Cotton gins.
3155 W Tatham—Preparing and spinning cotton, wool, flax, and other fibrous materials
3156 N. J. Amies—Fabric to be employed as a substitute for elastic woven or braided webs.

DATED NOVEMBER 25th, 1862.

3157 J. Moule—Deodorising mineral oils and hydrocarbons.
3158 T. & L. Robertshaw—Textile fabrics.
3159 A. L. Woolf—Metallic alloy.
3160 E. Wadsworth—Braid.
3161 J. S. Jarvis & J. H. Brierley—Leather collars.
3162 W. B. Caulfield—Porous stems for tobacco pipes.
3163 G. Henderson—Steam engines.
3164 G. Ranson—Preparing clay for brick making and other purposes.
3165 A. V. Newton—Sewing machines.
3166 W. Longley—Making bricks.
3167 T. M. Eitou—Soap.

DATED NOVEMBER 26th, 1862.

3168 T. Fletcher—Rollers, cans, spools, and bobbins.
3169 J. Aspell & E. Booth—Looms for weaving.
3170 J. Steinthal—Moulders' blacking.
3171 F. Palling—Fountain penholder.
3172 J. F. Foveaux—Pulverising or dividing liquids into spray.
3173 W. Austin—Cartridge cases.
3174 J. R. Dauks & B. P. & R. P. Walker—Boot and shoe heel and toe tips and clog irons.
3175 A V. Newton—Preparing oxide of zinc as a pigment.

DATED NOVEMBER 27th, 1862.

3176 J Halford—Treatment of a mineral sub tance to be used in the manufacture of iron and steel in the processes of casting and moulding metals, and the manufacture of paint.
3177 A. A. Phéloux & P. A. Paumier—Atmospheric sailing propeller.
3178 F. W. Hartley—Obtaining certain products resulting from the manufacture and purification of coal gas.
3179 T. Keyworth—Motive power machinery.
3180 W. T. Rowlett—Knit or looped fabrics.
3181 D. & D. Auld—Working furnaces and steam boilers.
3182 J. L Linton—Generating steam.
3183 D Veerkamp & C. F. A. Van Trigt—Treatment of old manufactured fabrics, in order to obtain useful fibrous products therefrom.
3184 W. Clarke—Preservation of animal and vegetable substances.
3185 W. Clark—Gas burners.

DATED NOVEMBER 28th, 1862.

3186 J. Carbonell—Preparing, manufacturing, and washing the paper pulp derived from the esparto plant.
3187 W. A. Waddington—Cutting wood.
3188 J. T. Caird—Steam engines.
3189 J. H. Johnson—Indicating the pressure of electric conductors in foreign bodies.
3190 F. Boecke—Sewing fabrics.
3191 J. Cresswell & E. T. Greves—Hearses and funeral carriages.
3192 S J. Browning—Brewing.
3193 W. Clark—Permanent way of railways.
3194 W. Buller & J. H. Mugford—Spur supporting rings for fixing plates, dishes, and other articles in glost ovens.
3195 J. F Delany & J. C. R. Okes—Double cylinder expansive steam engines.
3196 J. Adams & W. C. White—Apparatus for boiling and evaporating.
3197 A. Dudgeon—Packing for steam and other engines and machinery.

DATED NOVEMBER 29th, 1862.

3198 W. E. Gedge—Clocks.
3199 T. Blackburn & M. Knowles — Looms for weaving.
3200 F G. Taylor—Washing machines
3201 J. Crompton—Ploughing, harrowing, clearing, and drilling land.
3202 T. Lloyd—Wheels of vehicles.
3203 T. Evans—Antigropbilos.
3204 W. Clark—Cutting corks and other stoppers.
3205 F. Vacher—Ornamenting playing cards.
3206 J. C. Robertson & W. C. White—Tap or cock.
3207 Rev. H. Moule — Locomotive engines, and apparatus for generating steam for steam engines.
3208 D. Sutton—Washing linen and other fabrics and garments.
3209 J Anderson, C.E.—Tyres of railway wheels, rails, switches, and crossings of railways.
3210 R. K. Penson—Warming railway carriages.
3211 M. Henry—Leather.

DATED DECEMBER 1st, 1862.

3212 H. L Emery—Thrashing machines.
3213 P. Bourne—Miners' lamps.
3214 G. F. Griffin—Permanent way of railways.
3215 T. Waller—Stoves.
3216 J. Irwin—Cultivating land.
3217 R. Flude—Looms for weaving narrow fabrics.
3218 J. Coppard—Appliances for horse shoes, to produce the effect of what is termed roughing.
3219 J. Romer—Bullion and metallic fine drawn wire.
3220 W. Clark—Apparatus applicable as a pump, water meter, hydraulic motor, or a steam engine.

DATED DECEMBER 2nd, 1862.

3221 P. W. Renter—New compound for dyeing and printing purposes.
3222 E. D Johnson—Pocket watches.
3223 B. Oldfield—Looms.
3224 A. V. Newton—Steam and other vessels.
3225 H. Twelvetrees—Cleaning knives, forks, and boots.
3226 H. Twelvetrees—Sawing, filing, mortising, and turning apparatus.
3227 H. Twelvetrees — Washing, wringing, and mangling machines.
3228 P. Brassert—Apparatus for saving life and property in cases of fire and burglary.
3229 J. & J. Craven & J. Robinson—Looms for weaving.
3230 G. F. Blumberg—Producing designs in or on glass.
3231 J. Wheatley—Construction of ships of war and the manufacture of armour plates for ships, forts, and batteries.
3232 T. Cook—Envelope folding machinery.
3233 G. T. Bousfield—Permanent ways of railways.
3234 G. T. Bousfield—Apparatus for discharging guns or ordnance.
3235 D. Graham—Steering and manœuvring ships or vessels
3236 A. P. Charles—Candles and night lights, and lamps for burning the same.
3237 R. K. Cautley—Electro thermal baths.
3238 H. J Simlick—Cigar and pipe lights.
3239 B. Browne—Knobs or handles or door locks, and the mode of connecting same with the sliding bolts thereof for advancing and drawing back said bolts.

DATED DECEMBER 3rd, 1862.

3240 H. Wilde—Electro magnetic telegraphs
3241 A. T. Becks—Cutting sheets of metal.
3242 R. B Thomas—Apparatus for turning over the leaves of music.
3243 C. F. Claus—Carboy hampers
3244 A Mortou—Lawn mowing machines.
3245 W H. Browne—Gas stoves.
3246 I. I. Abadie—Imitation lace and guipure veils.
3247 A. F. Edeu—Taking minute photographic pictures and magnified pictures of microscopic objects.

DATED DECEMBER 4th, 1862.

3248 C. H Roeckner—Coffer dams for enclosing or keeping back the flow of water and preventing inundations, and apparatus for lowering or raising weights.
3249 H. Swan—Stereoscopic apparatus.
3250 J. Grant—Turntables for portable railways.
3251 R. D. Kay—Finishing of endless machine blankets for printing purposes.
3252 J. Braddock—Apparatus for effecting the separation of impurities from the water employed in steam boilers, and for effecting the circulation of the said water.
3253 F. D. Delf & T. C. Gibson—Apparatus whereby petroleum and other oils and hydro carbons can be safely carried and stored.
3254 G. Lewal—Hot air apparatus in cast iron or any other metal or substance consisting of prismatic tubes, to be applied to chimnies with flues and heat conduits.
3255 H. Castelbon—Press to be used in the manufacture of tiles and bricks.
3256 J. Robinson—Ships and vessels.
3257 J. Biggs, J. Johnson, T. Richardson, and T. Arnold—Warp fabrics.
3258 R. Wallis—Loading and unloading vessels and transporting sacks, casks, and other packages from one landing place to another.
3259 R. Hornsby, jun.—Cutting and pulping turnips and other vegetables.
3260 T. G. Webb—Articles of pressed glass.

DATED DECEMBER 5th, 1862.

3261 M. Tildesley & E. Sharpe—Earthenware knobs.
3262 L. Christoph, W. Hawksworth, and G. P. Harding—Drilling, drawing, and rolling metals.
3263 E. B Wilson—Railway wheels.
3264 T. E. Blackwell—Barometers or instruments for measuring altitudes or the pressure of the atmosphere or elastic fluids.
3265 J. M. Rigby—Pressing cotton or other fibrous materials.
3266 P. Cowan—Purifying gas.
3267 W. J. Smith—Collars, cuffs, and wristbands.
3268 E. Walton—Wearing apparel for the neck.
3269 C. Galleti & F. Stefano—Furniture.

DATED DECEMBER 6th, 1862.

3270 H. A. Bonueville—Fabrication of stockings and socks.
3271 R. Thorp—Covering for steam boilers and other surfaces to prevent the radiation of heat.
3272 J. & M. Craig—Apparatus for the manufacture of clay.
3273 G. Wright—Food for cattle.
3274 W. McNaught—Washing and drying textile fabrics and materials.
3275 J. Campbell—Hackling flax and other fibres.
3276 J. Burchall & E. Borrows—Propellers for ships and other navigable vessels.
3277 E. & W. Ullmer—Cylinder printing machines.
3278 R. McClintock—Carriage axles.
3279 R. E. Donovan—Apparatus for the prevention of railway accidents.
3280 J. Joce—Compositions for producing artificial sea water.
3281 W. Palliser—Screw bolts.

DATED DECEMBER 8th, 1862.

3282 G. Lowry—Hackling flax, and preparing to be spun flax, hemp, and tow.
3283 J. L. Budden—Obtaining and applying motive power for propelling or other purposes.
3284 J. Sellars—Pulp or half stuff used in the manufacture of paper and pasteboard.
3285 P. Todd—Pickers used in looms for weaving.
3286 R. A. Brooman—Kneading machines.
3287 G. A. Huddart—Butt ns.
3288 C. Sanderson—Bands for driving machinery and lifting weights.
3289 W. E. Newton—Preserving animal substances.
3290 J. Hilliar—Hinges and joints.
3291 J. Hilliar—Ventilating, and the exclusion of dust or draught, insects, or other animals from apartments, carriages, or other confined spaces.
3292 E. T. Hughes—Electro-galvanic apparatus.
3293 J. A. & C. L. Kiesling—Renewing worn out files and rasps.
3294 J. H. Johnson—Steam generators.

DATED DECEMBER 9th, 1862.

3295 T. Wingate, jun.—Dredging machinery.
3296 V. Mirland—Manufacturing paste with the dried pulp of rhubarb to be used as preserve.
3297 M. F. Benton—Gunpowder.
3298 W. Clark—Photographic apparatus.
3299 R. A. Brooman—Treating liquorice root to obtain liquid and solid extracts therefrom.
3300 G. Jeffries—Breech-loading fire arms.
3301 J. Howard, J. Bullough, & T. Clegg—Preparing cotton to be spun.
3302 J. M. & E. D Syers—Deodorising petroleum, shale, and other oils.
3303 P. Effertz—Making bricks, tiles, and drain pipes.
3304 W. E. Newton—Fire arms.
3305 E. B. Wilson—Rolling metals.

DATED DECEMBER 10th, 1862.

3306 J. Lamb—Tissue paper for transferring patterns and designs.
3307 W. Inglis—Steam boilers.
3308 L. A. L sage—Making and moulding fruit jellies and preserves.
3309 J. R. C. Tannton—Ornamentation of metallic bedsteads.
3310 S. B. Whitfield—Dovetail joints used in metallic bedsteads.
3311 M. Osborne—Cast iron fenders.
3312 A. P. Price—Colours.
3313 D. Chalmers—Textile materials.
3314 W. A. Turner—Cutting or paring starch.
3315 W. Clark—Umbrellas.
3316 J. King—Signalling on railways.
3317 E. Toynbee—Extracting oils and fatty matters from shoddy or refuse wool, skins, or skin pieces, glue pieces, cotton waste, and other animal or vegetable matter, and producing an artificial manure.

DATED DECEMBER 11th, 1862.

3318 I. Spight—Horse hoes.
3319 W. Tristram & H. Brereton—Sizing yarns and threads.
3320 J. R. Brecon & T. Douglas—Fire bricks.
3321 R. A. Rumld — Printing textile and felted fabrics.
3322 R. Clark—Machinery for boring, winding, and lifting for mining purposes.
3323 A. W. Burgess—Preparation of anchovies.
3324 J. Imray—Mixing and kneading apparatus.
3325 W. Goulding—Ploughs.
3326 T. E. Vickers—Ordnance.

DATED DECEMBER 12, 1862.

3327 G. Winiwarter—Portable houses, walls, or partitions of buildings, strong rooms, safes, refrigeratories, reservoirs, piers, and other structures.
3328 H. Sanderson—Knives and forks.
3329 J. E. Roussel—Hand and power looms.
3330 J. Gaskell & H. Walmsley—Regulating the tension of yarn in warping, winding, sizing, and weaving.
3331 C. Hancock & S. W. Silver—Compounds and substances applicable for electric insulation.
3332 A. Mills—Reefing and unreefing sails of ships.
3333 G. Clark—Fortification for the defence of ships, batteries, and forts.
3334 S. Fox—Gas retorts.

DATED DECEMBER 13th, 1862.

3335 J. Brown—Armour plates.
3336 J. W. Baker—Spinning cotton.
3337 J. Brown—Hydraulic machinery.
3338 E. Thorold—Drill braces.
3339 C. Corbet—Rails for railways.
3340 R. Aitken—Locomotive engines.
3341 J. Petrie—Washing wool.
3342 J. J. Thompson—Making pies.
3343 W. E. Newton—Repairing the rails, points, and switches of the permanent way of railways.
3344 M. Henry—Fitting propellers to ships.

DATED DECEMBER 15th, 1862.

3345 M. J. Roberts—Preparing and spinning cotton.
3346 W. Bestwick—Braiding machines.
3347 R. Staufield & J. Dodgeon—Looms for weaving.
3348 G. Buchanan—Crushing sugar canes.
3349 W. Phelps—Locks.
3350 M. Hyams—Cigars.
3351 E. B. Wilson—Rolling metals.
3352 R. Kirk—Stopping railway carriages.

DATED DECEMBER 16th, 1862.

3353 J. McInnes & E. F. Prentiss—Distillation and treatment of petroleum.
3354 J. Farley & J. Crowther—Steam engines.
3355 G. C. Warden—Ornamenting textile fabrics.
3356 J. S. and S. Hancock—Anti-garotte knives.
3357 O. Dickin—Table fork.
3358 J. J. Lemon—Book trays.
3359 W. and A. Smedley—Warp lace machines.
3360 W. Hudson, H. Moore, C. Catlow, and S. Newhurey—Looms for weaving.
3361 J. L. W. Thudichum—Collecting human excreta.
3362 3362 G. C. Wallich—Deep sea sounding.
3363 R. Schomburg and A. Baldamus—Oils.
3364 H. Jorns—Clocks.

DATED DECEMBER 17th, 1862.

3365 R. Hattersley — Classing printers' types for composing machines.
3366 W. Tongue—Preparing fibrous materials.
3367 A. Albini—Fire-arms.
3368 C. Defries—Lamps.
3369 T. Knowles—Preparing and spinning cotton.
3370 J. R. Hampson—Packing bales.
3371 J. Thorne—Regulating the flow of gas.
3372 J. Ramsbottom and G. Hacking—Measuring and registering the flow of water.
3373 J. W. Hawden—Spinning cotton.
3374 T. C. Burraclough—Tobacco.
3375 F. De Wylde—Preservation of lead surfaces.
3376 D. Latter—Ploughs.
3377 R. Wheeler—Ploughs.
3378 H. Burton—Castors.
3379 G A Huddart—Buttons
3380 W Clark—Holders for lamps
3381 C J L Leffler—Armour for ships

DATED DECEMBER 18th, 1862.

3382 E Precht and V Toepken—Matches
3383 E Lepainteur—Salt for dying textile materials
3384 J Clayton—Reverberatory furnaces
3385 E Habel and E Suckow—Spinning cotton
3386 G Russell—Cranes
3387 W V Wilson and F A Manning—Colouring matters
3388 J and A Brierley—Carding engines
3389 J Pernad—Purpurine
3390 J Savory—Powders for diseases of the throat
3391 J Longland—Street lamps
3392 S C Lister—Spinning flux and silk
3393 A V Newton—Transmitting power
3394 I Holden—Preparing and combing wool
3395 I Holden—Washing wool
3396 J L W Thudichum—Preservation of beer

DATED DECEMBER 19th, 1862.

3397 W S Longridge—Rolling tyres and hoops
3398 E B Wilson—Forging and pressing metals
3399 D Davison—Telescopes
3400 A V Newton—Attaching metal eyelets to cloth
3401 J Dalton—Knitting machinery

DATED DECEMBER 20th, 1862.

3402 J B Morrison—Washing machines
3403 F W Harvey—Connecting rudders to ships
3404 A T Blakely—Breech-loading ordnance
3405 J Nettleton—Stoves
3406 J Michaelis and J Rubino—Locks for purses
3407 J Cowper—Tearing up rags
3408 A V Newton—Automatic toy figures
3409 J Platt and W Richardson—Scutchers of cotton
3410 W Perkins—Substitute for turpentine

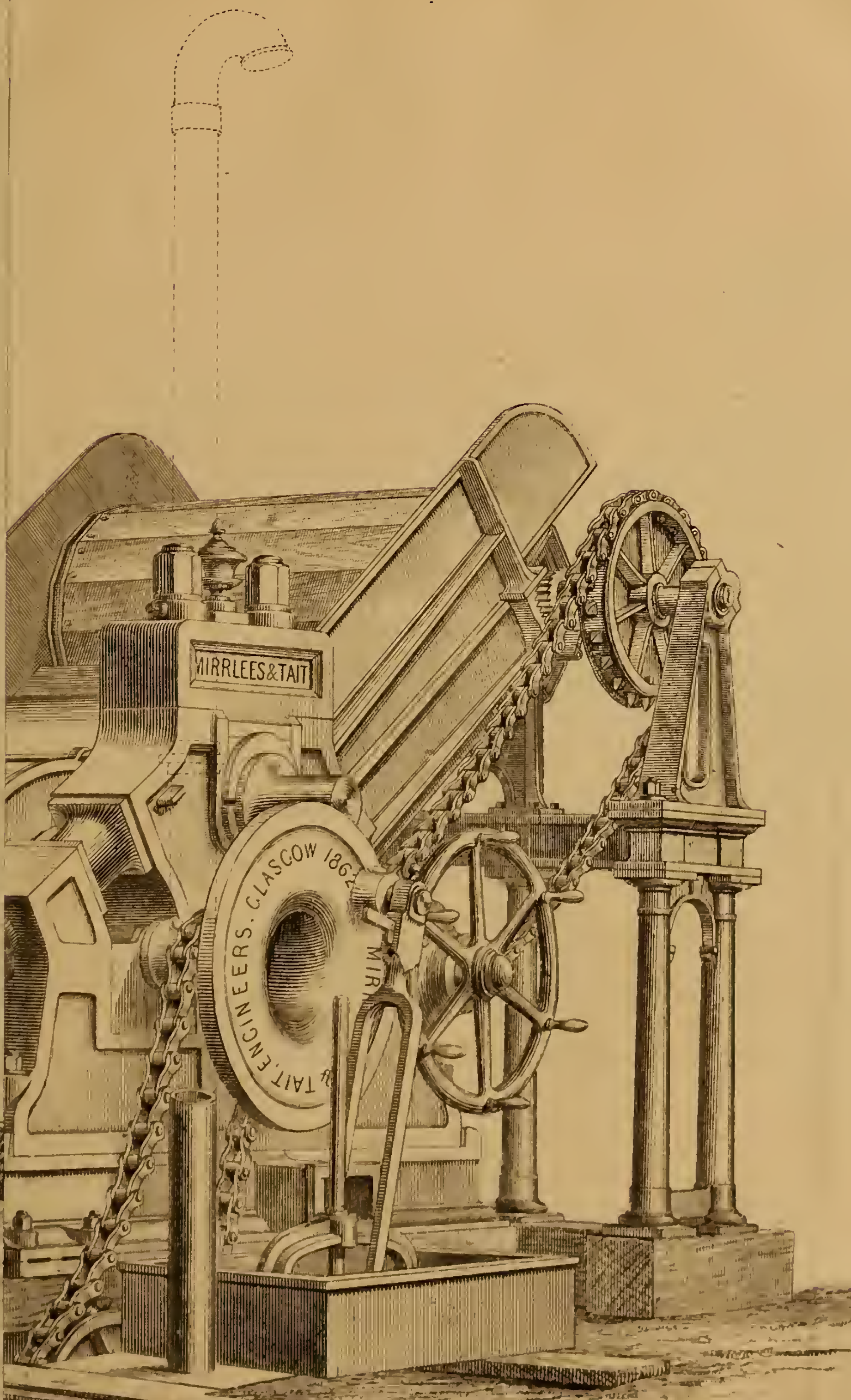
DATED DECEMBER 22nd, 1862.

3411 F C Bakewell — Transmitting and receiving communications by means of electricity
3412 J McLean—Obtaining oil from shale
3413 W Francis—Cutting soap
3414 A S Stocker—Rolling iron
3415 G E M Gerard—Fabrication of threads from vulcanized india rubber
3416 E R Dano—Goffering apparatus
3417 R A Brooman—Stoves
3418 M Clark—Treating waste liquors obtained when dyeing turkey red colours
3419 J B Daihoff—Cutting files
3420 C Farrar—Treating certain fibrous materials

DATED DECEMBER 23rd, 1862.

3421 C Pieper—Governor for steam engines
3422 F Parker—Carriages
3423 R A Brooman—Colouring matter
3424 C A F Collette—Lac
3425 J Patterson—Grinding, crushing, cutting, cleaning, and shelling farm or vegetable produce
3426 E B Wilson—Malleable iron and steel
3427 G Haseltine—Converting petroleum or coal oil into gas
3428 J Whitley and J W Burton—Permanent way of railways
3429 S Russell—Stereoscopes

GINE,



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SUGAR-MILL AND STEAM ENGINE,

CONSTRUCTED BY MESSRS MIRRLEES & TAIT, *ENGINEERS*,

GLASGOW.

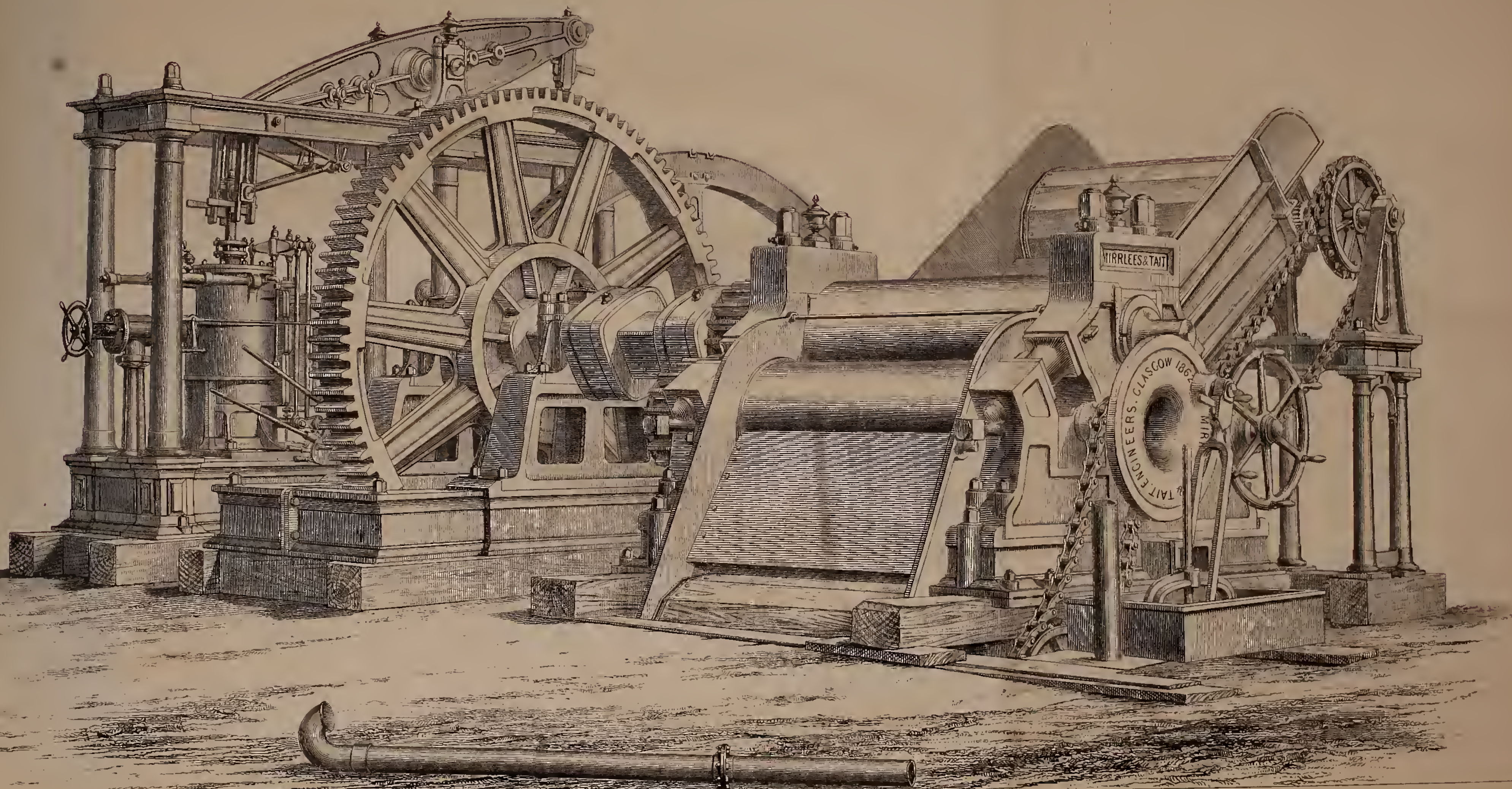
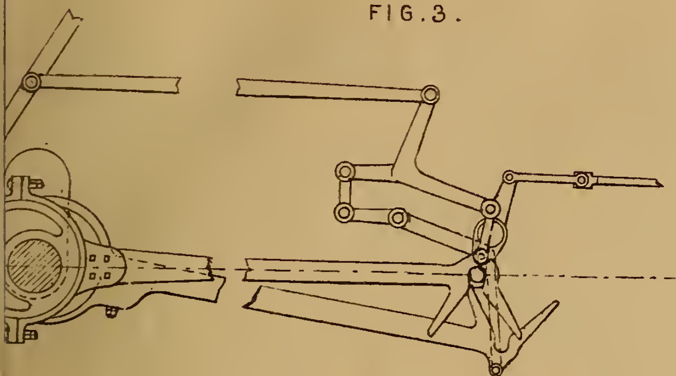
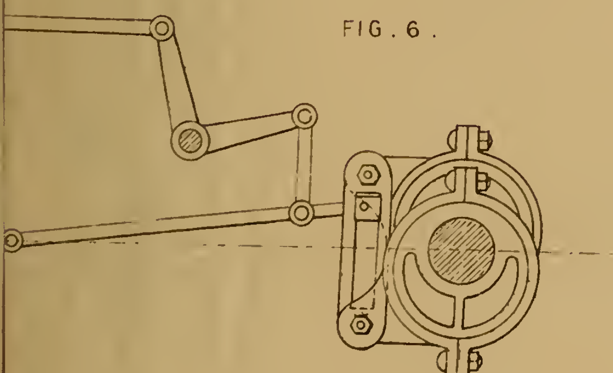


FIG. 3.



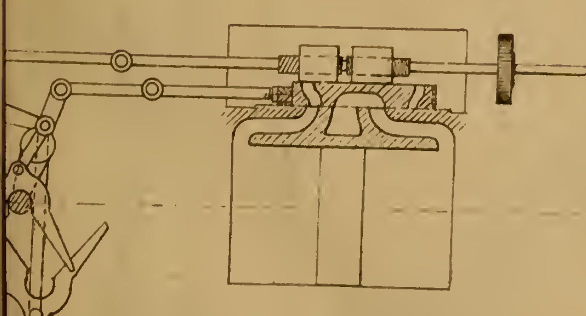
SHARP & ROBERTS' VALVE-GEAR – 184C.

FIG. 6.



WILLIAMS' EXPANSION-GEAR.

FIG. 9.



MEYER'S EXPANSION-GEAR – 1842.

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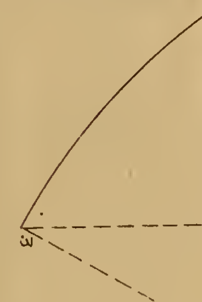
and good workmanship



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OF LOCOMOTIVE

32.)
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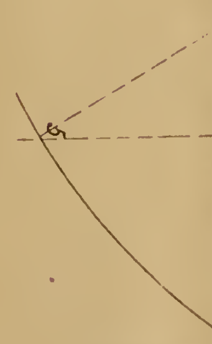

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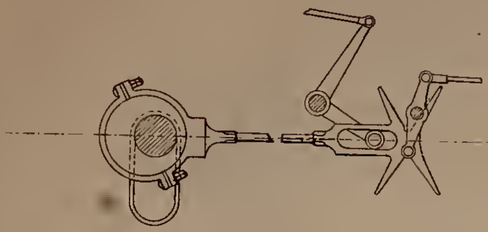
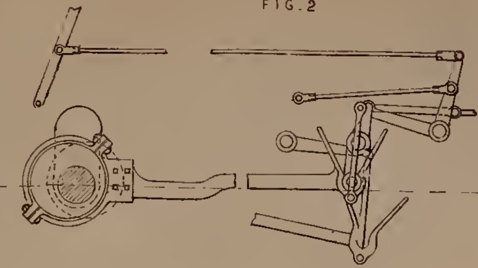
LOCOMOTIVE ENGINEERING.

FIG. 1



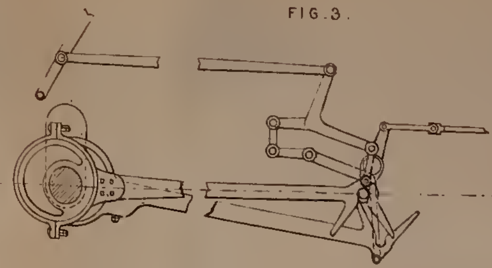
CARMICHAEL'S VALVE-GEAR – 1830.

FIG. 2



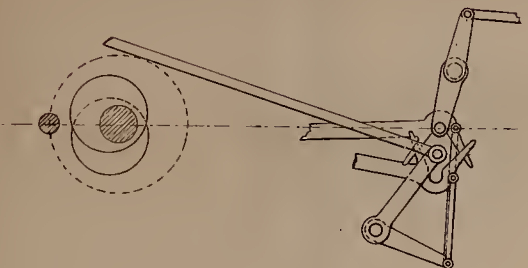
STEPHENSON'S VALVE-GEAR – 1837.

FIG. 3.



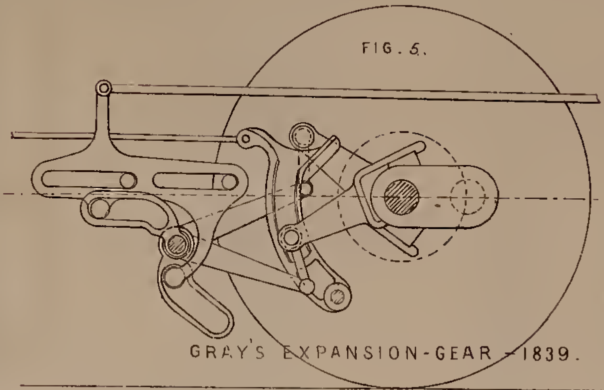
SHARP & ROBERTS' VALVE-GEAR – 1840.

FIG. 4.



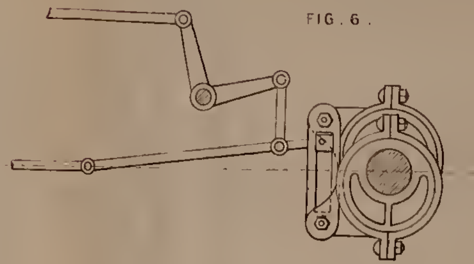
BUDDICOM'S VALVE-GEAR 1840.

FIG. 5.



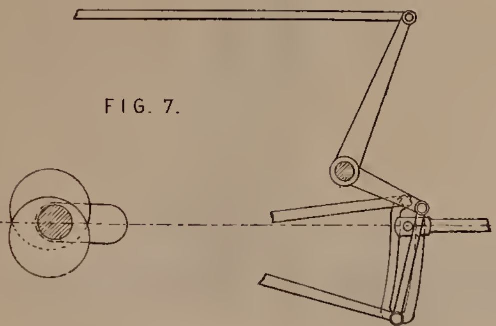
GRAY'S EXPANSION-GEAR – 1839.

FIG. 6.



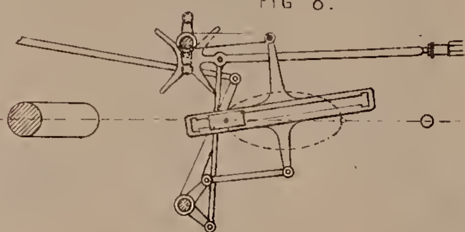
WILLIAMS' EXPANSION-GEAR

FIG. 7.



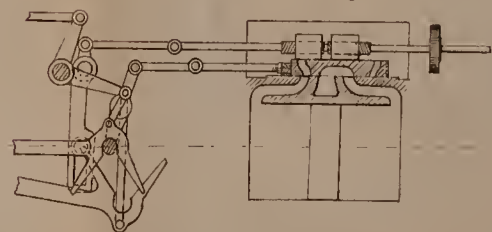
STEPHENSON'S LINK MOTION – 1843

FIG 8.



HAWTHORN'S VALVE-GEAR – 1838.

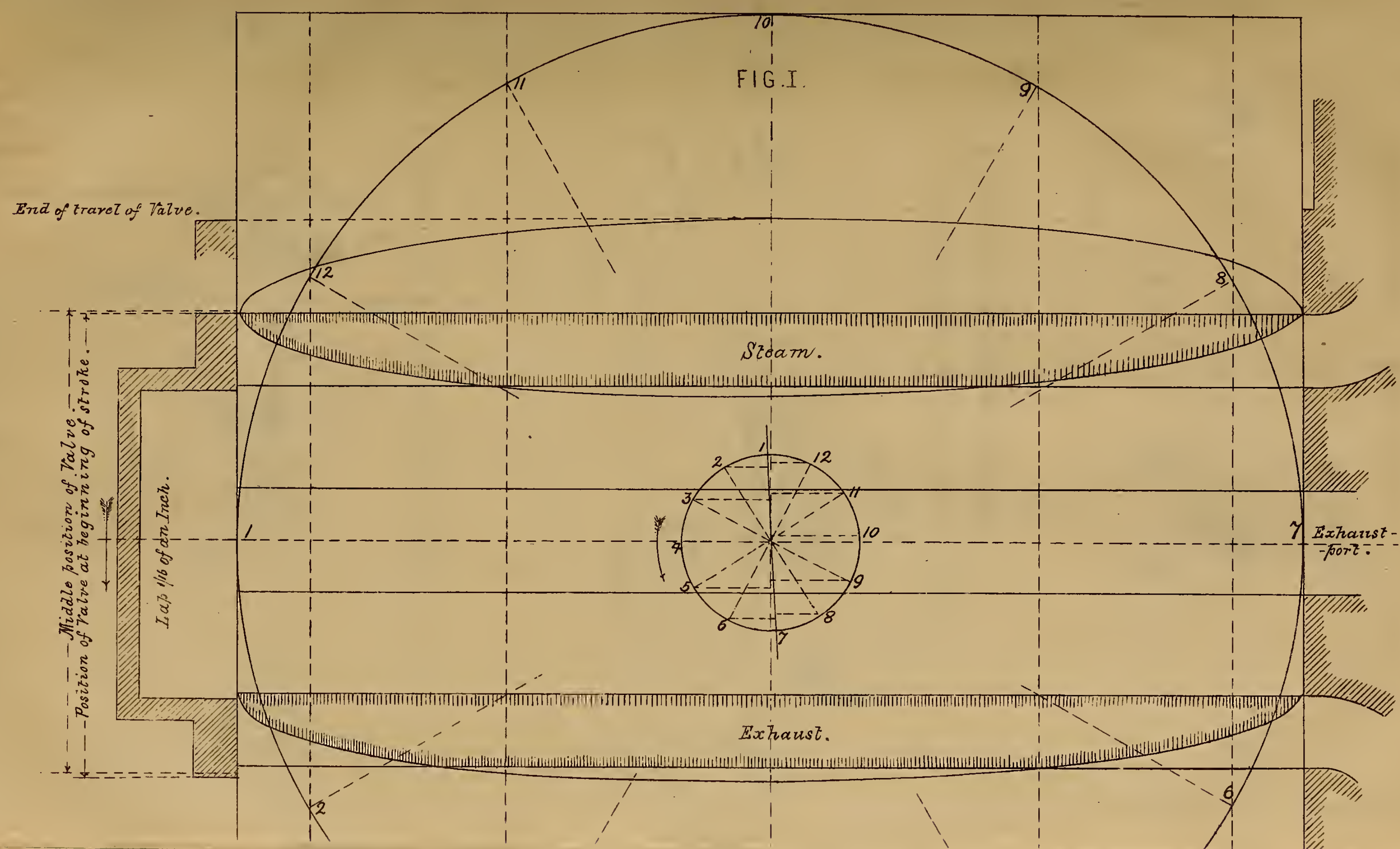
FIG 9.



MEYER'S EXPANSION-GEAR – 1842.

MITH, C.E. Direx.

GENERAL DIAGRAM OF MOTION OF OLD VALVE.



THE ARTIZAN.

No. 2.—Vol. 1.—Third Series.

FEBRUARY 1st, 1863.

SUGAR MILL AND STEAM ENGINE.

By Messrs. Mirrlees and Tait, Glasgow.

(*Illustrated by Plate* 230.)

Our copper-plate engraving represents a perspective view of a sugar mill and steam engine complete, manufactured by Messrs. Mirrlees and Tait, of Glasgow, who have earned a wide-spread reputation for the excellence of the machinery manufactered by them for the extraction of the juice from the sugar cane.

The subject represented by our plate formed a very prominent object amongst the machinery in motion in the late International Exhibition, where, doubtless, numerous of our readers have seen the apparatus at work. We have also included a notice of the machinery exhibited by Messrs. Mirrlees and Tait, in Number 6 of the series of Artizan International Exhibition supplementary numbers, and in which we also gave woodcut illustrations of the sugar mill only.

The mill has three crushing rollers of cast iron, each 33 in. diameter, and 7 ft. long, the upper one of which drives the two side ones by strong pinions keyed on the ends of their respective shafts or gudgeons. This upper roller revolves in a line with the axis of the largest of the train of heavy spur wheel gearing for transmitting the power of the engine to the mill, and is connected to it by a short malleable iron shaft, with two large loose fitting couplings, which allow it to be easily disconnected. It is secured from rising by strong cast iron covers and four wrought iron bolts, which pass downwards through the headstocks, mill bed, and the heavy timbers on which the mill sits, beneath which they are secured by wrought iron washers and cottars.

Each side roller can be adjusted separately to the requirements of its work by large set screws, bearing on thick malleable iron plates fitted to the backs of the journal bushes.

The headstocks, which carry the bearings of all the rollers, are necessarily very strong, having to resist the entire force of the engine acting through a leverage of 16 to 1. They are so made that each roller can be taken out or replaced without interfering with the other parts.

The velocity of the surface of the rollers is about 18 ft. per minute, and the weight of each, with its malleable iron shaft or gudgeon, about 10 tons.

The mill bed upon which the headstocks are solidly fixed is a casting in one piece, which serves also to receive the cane juice as it falls from the rollers. The juice is delivered by a spout at one side of the bed-plate into a separate cast iron cistern provided with perforated copper strainers.

In this cistern—for the purpose of elevating the cane juice into the proper receiver—is placed a very large pump lined with brass, with a brass bucket worked slowly from a crank disc on the end of one of the roller gudgeons.

The sugar canes are distributed on an endless travelling table or cane-carrier, also driven from the end of one of the roller gudgeons by a friction clutch and pitch chain gear. The movement of the cane-carrier brings the canes to the mill, and projects them over a steep inclined feeding-table into the bite of the upper and first roller. Passing through these, the canes are deflected upwards by the concave upper surface of an iron beam, fixed between the rollers into the bite of the upper and the other side roller, where the utmost amount of juice is extracted, and the refuse cane or megass is delivered out to another endless table, which carries it away to be dried in the sun or stored for fuel.

The product of this mill in cane juice is estimated at 4000 gallons per hour, equal to about 2 tons of dry sugar.

A prize medal was awarded by the Jury of Class 8 to Messrs. Mirrlees and Tait for the general excellence, good design, and good workmanship of the machinery we have just described.

The mill is worked by a high pressure beam steam engine, constructed upon a very deep massive bed-plate, cast in one piece. Into this the columns are fitted the entire depth of the bed, and the whole is bound together by strong malleable iron bolts, cottared into the bed-plate below, passing through the centre of the columns, and secured above the entablature by large nuts.

The steam cylinder is 22in. in diameter, having a stroke of 4ft. 6in. Besides the ordinary slide valve there is a gridiron expansion valve, worked by an eccentric on the crank shaft, and by means of a slotted link the amount of expansion can be varied with the utmost facility while the machinery is at work.

The power of the engine is transmitted to the mill, and the speed reduced in the proper ratio, by a double train of very heavy spur wheels, the axes of which are rigidly secured to a deep cast iron bed-plate of similar design to the engine bed. The largest wheel of this train is expressly designed for the specialities of the work to be performed. The centre, arms, and segments are all made in separate pieces. The arms are of circular section and hollow, thus securing the best distribution of the metal for all strains, the whole fitted with great accuracy and secured by turned bolts.

A CRITICAL AND HISTORICAL REVIEW OF LOCOMOTIVE ENGINEERING.

By J. J. Birckel.

(*Continued from page* 8.)

(*Illustrated by Plates* 231 *and* 232.)

To proceed in the manner sketched out at the outset of our subject, we have now to lay before our readers, and to inquire into the various questions relating to the steam engine proper, under which name is to be comprized the cylinder, the steam distributing apparatus, and those parts of machinery by means of which motion is finally communicated to the engine.

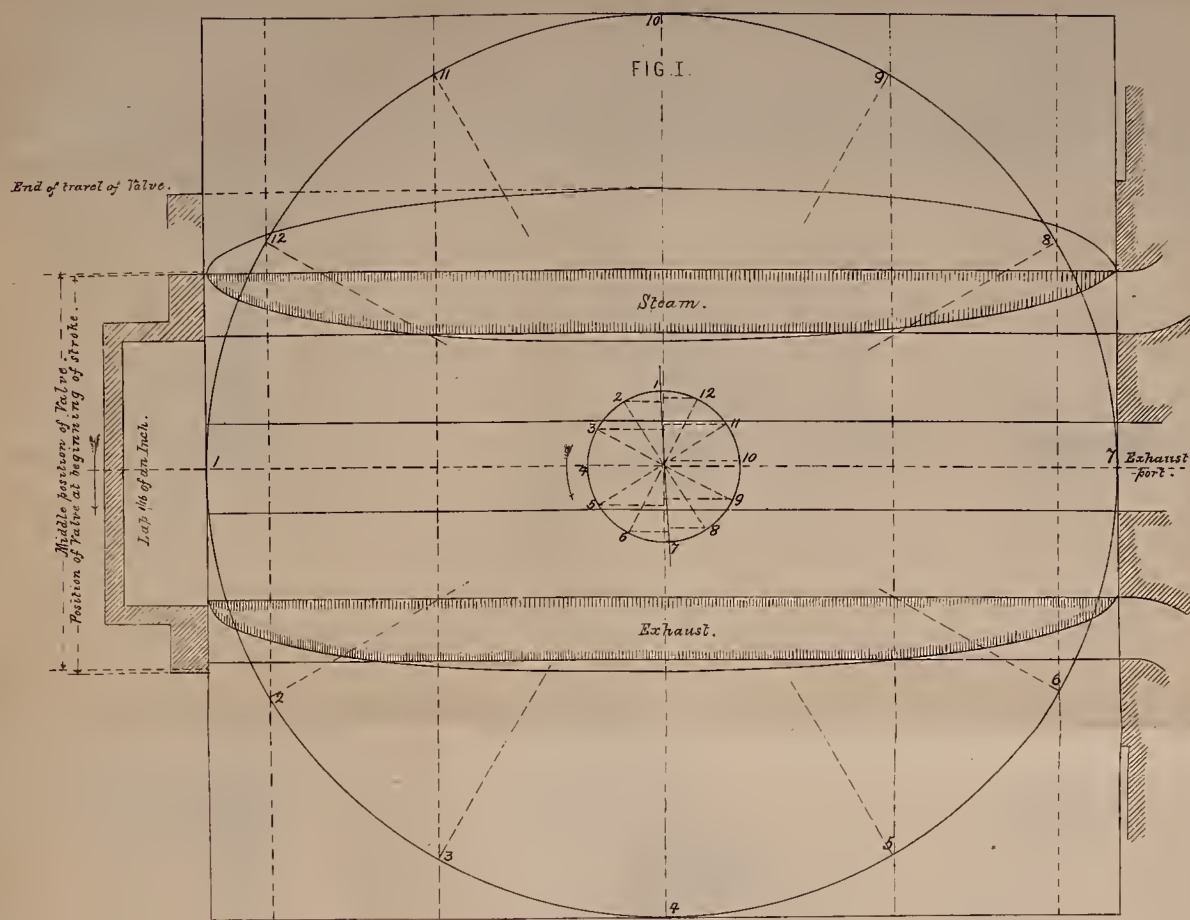
In treating of the boiler, we have seen already that by adopting Pambour's method of determination of the heating surface, the diameter of the cylinder, the stroke and the diameter of the driving wheel are conspicuous elements in the formula which defines the amount of that heating surface. We reproduce it here for the facility of reference,

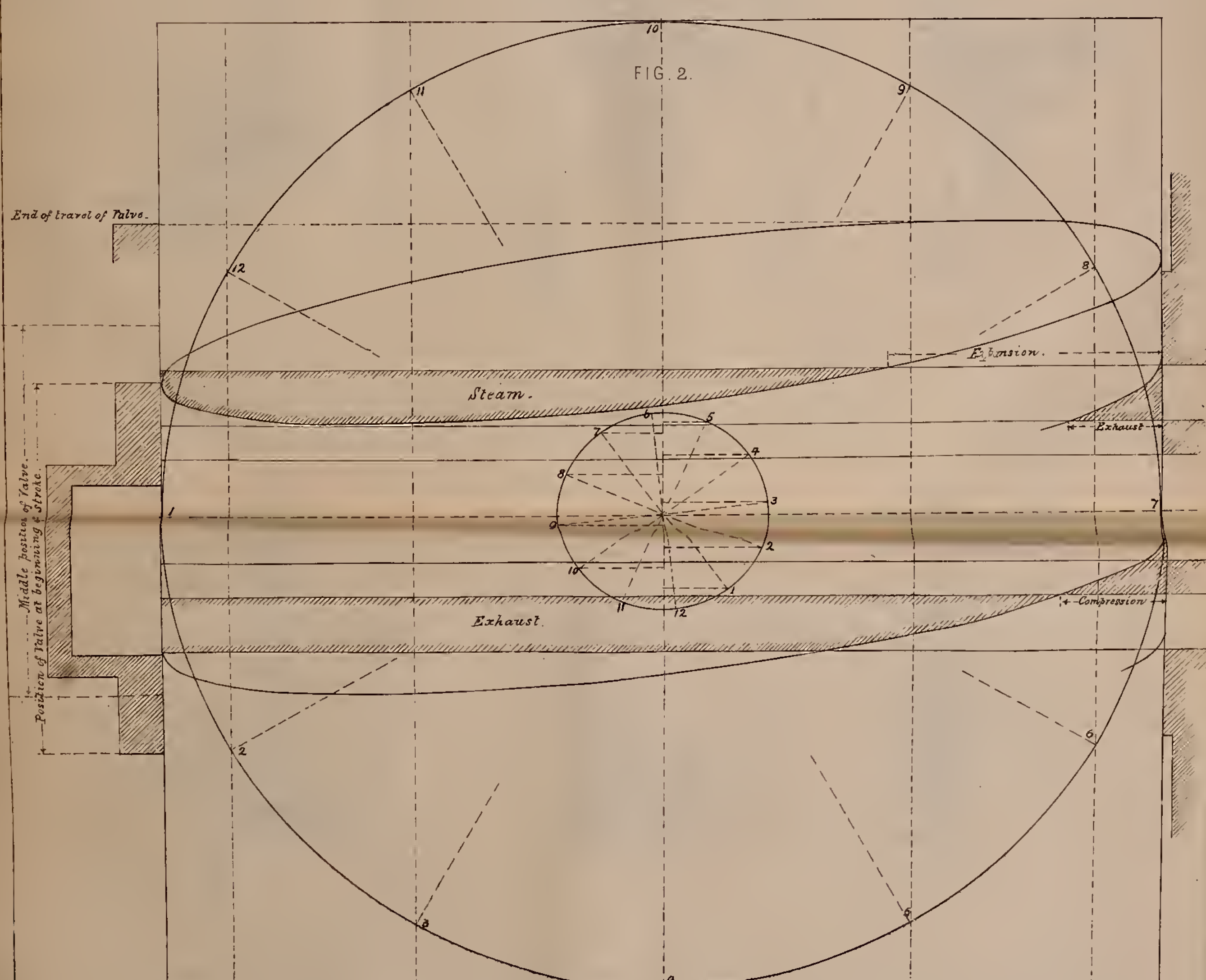
$$A = e \cdot \frac{31{,}318}{c \cdot v} \cdot \frac{d^2 l}{D} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

Where all the symbols keep their former meaning, but where e stands for the co-efficient of efficiency of steam for the particular grade of expansion at which it is intended to work the engine when it performs its maximum duty at the speed v.

This formula teaches us that the heating surface required to perform a certain duty, is directly proportional to the product of the square of the diameter of the cylinder, by the stroke, and inversely as the diameter of the driving wheel; and as the diameter of the cylinder (which is in the main regulated by the total resistance to be overcome), may be made to vary by altering the ratio of stroke to diameter of driving wheel, it is necessary to inquire which are the best proportions to be adopted for these several elements of the engine. It will be at once perceived, however, that for a given resistance at the circumference of the driving wheel the factor $\frac{d^2 l}{D}$ must remain constant, for if the ratio $\frac{l}{D}$ be made to vary,

GENERAL DIAGRAM OF MOTION OF OLD VALVE.





GENERAL DIAGRAM OF MOTION OF NEW VALVE.

W. SMITH, C.E. del.

d^2 will vary at the same time in an equal but inverse ratio; the relative values, d, l and D, therefore, cannot in any way affect the value A of the heating surface, and must be decided upon from considerations having reference to the efficient working of the engine alone. In treating of this question, Mr. Clark says, "It is desirable to limit the diameter of piston, and consequently the area, in order to prevent an excessive concentration of pressure on the hearings of the driving wheel; it is desirable also to limit the speed of piston in order to moderate the number and violence of the reciprocations," to which we would also add, *in order to reduce as much as possible the bad effects of wire drawing.* In his chapter treating of the data regulating the general proportions of the engine, Mr. Clark says that the maximum speed of piston should be 600ft., or 15ft. per minute for every mile of speed per hour; that the orthodox ratio of diameter of cylinder to stroke is as 3 to 4, and that the ratio of stroke to diameter of driving wheel should be from $1 \div 3\frac{1}{2}$ to $1 \div 4$, for engines of high speed, and should not in any case exceed $1 \div 2$.

In order to test the correctness of these statements, we must refer to results obtained from actual practice, which, at the present day, should be the best source of information upon all questions governed chiefly by practical, rather than by theoretical considerations, and subjoined is a short table of proportions of engines from the recent practice of Messrs. Sharp, Stewart, and Co., Fairbairn, Ramsbottom, and others.

TABLE A.

Designation of Engines and Makers.	Diameter of Cylinder.	Stroke.	Diameter of driving wheel.	$\frac{d}{l}$	$\frac{l}{D}$	$\frac{d^2 l}{D}$
EXPRESS AND PASSENGERS.	in.	in.	ft. in.			
Sharp, Stewart, and Co.'s, London, Chathan, and Dover.	17	22	6 6	3 ÷ 3·88	1 ÷ 3·54	0·565
Sharp, Stewart, and Co.'s, Great Western	16	24	7 0	3 ÷ 4·5	1 ÷ 3·5	0·508
Sharp, Stewart, and Co.'s, London aud North Western..	16	22	7 0	3 ÷ 4·12	1 ÷ 3·82	0·465
Sharp, Stewart, and Co.'s, Lucca and Pistoja...............	15	20	5 6	3 ÷ 4	1 ÷ 3·3	0·473
Ramsbottom's Lady of the Lake............................	16	24	7 6	3 ÷ 4·5	1 ÷ 3·75	0·474
Ramsbottom's Crewe common passenger	16	20	7 0	3 ÷ 3·75	1 ÷ 4·2	0·423
Fairbairn's Wolverton passenger	16	21	6 0	3 ÷ 3·93	1 ÷ 3·43	0·518
			Mean...	3 ÷ 4·1	1 ÷ 3·72	0·490
GOODS' ENGINES.						
Sharp, Stewart, and Co.'s. London, Chatham, and Dover	17	24	5 0	3 ÷ 4·23	1 ÷ 2·5	0·802
Sharp, Stewart, and Co.'s, Dublin and Wicklow	16	24	5 0	3 ÷ 4·5	1 ÷ 2·5	0·711
Ramsbottom's, Crewe..	17	24	5 0	3 ÷ 4·23	1 ÷ 2·5	0·802
McConnell's, Wolverton..	16	24	5 6	3 ÷ 4·5	1 ÷ 2·8	0·646
Fairbairn's, Wolverton	18	24	5 0	3 ÷ 4	1 ÷ 2·5	0·900
			Mean...	3 ÷ 4·29	1 ÷ 2·56	0·772

It appears from this table that for express or passenger engines, the ratio of diameter to stroke is about as 3 to 4, and for goods engines as 3 to $4\frac{1}{3}$ nearly, and as these ratios are regulated absolutely by the two general condititions, stability upon the rails, and available space between the rails, —no great departure from them is possible in practice, and on that account we feel inclined to qualify them as the only possible ratios, rather than the orthodox ratios; a similar remark may be made regarding the ratio of stroke to driving wheel, which, in the case of engines for quick traffic, is governed by the practical limit to speed upon the rails; and in the case of goods engines, by considerations of commercial economy, which we know are far from being absolute, as is evidenced by a comparison between the goods engines of this and of other countries, which shows that while here the diameter of driving wheels is from 5ft. 0in. to 5ft. 6in., in France and in America, it is more generally 4ft. 6in., and even less than that.

These ratios being decided upon, nothing would be easier than to define the diameter of the cylinder and the stroke for a given resistance at the circumference of the drivimg wheel, and for an assumed mean pressure in the cylinder: it being a universal practice now, to supply the engine with two cylinders, these dimensions will be obtained from the following general equation:—

$$144\, p_a \cdot \frac{\pi d^2}{4} \cdot 4\, l = \mathrm{R}t\, \pi\, \mathrm{D}$$

which for

$$l = \frac{4}{3} d$$

becomes

$$144\, p_a \cdot \frac{4}{3} d^3 = \mathrm{R}t\, \mathrm{D}$$

and

$$d = \sqrt[3]{\frac{3}{4} \cdot \frac{\mathrm{R}t\, \mathrm{D}}{144\, p_a}} \quad \text{.....................} \quad (9)$$

and for

$$l = \frac{4{\cdot}29}{3} d$$

$$d = \sqrt[3]{\frac{3}{4{\cdot}29} \cdot \frac{\mathrm{R}t\, \mathrm{D}}{144\, p_a}} \quad \text{..................} \quad (10)$$

in which formula p_a expresses the mean actual pressure upon the square inch of piston, aud the meaning of the other symbols remains as previously.

If for instance we would find the diameter of cylinder and stroke required to perform, the duty expressed by formula (1), of our previous paper in THE ARTIZAN of last month, in which case the total resistance, including back pressure at the circumference of the driving wheel, is 7561lbs.; taking p_a at 90lbs. and D = 8ft., we should have

$$d = \sqrt[3]{\frac{3}{4} \times \frac{7561 \times 8}{144 \times 90}} = 1{\cdot}5 \text{ ft.} = 18 \text{ in.}$$

which would give a stroke of 24 inches.

The method of course might be reversed, and, instead of assuming a certain mean pressure, we might assume the dimensions of the cylinder, and find the pressure required for these given data. We believe, however, that the former method is to be preferred, because in the present state of matters we are able to ascertain pretty accurately what mean actual pressure we have in the cylinder for a given maximum pressure in the boiler; and since we know that *high pressure* and *economy* are two correlative facts, by adopting the former method the engine may at once be made to work under the most economical circumstances possible, so far at any rate as pressure is concerned.

To define the mean actual pressure in the cylinder in terms of the pressure in the boiler, we shall not have recourse to Mr. Clark's formula for mean effective pressures, having found it to be incorrect in its results, and deficient of the element of loss of pressure sustained in the passage from the boiler to the cylinder; but we find the means of supplying our present

want, partly from the valuable plate of indicator diagrams taken from the engine "Great Britain," on the Great Western Railway in 1847, '49, and '50; and partly from the chapter treating of the relative pressure in the cylinder, the valve chest, and the boiler. The former enables us to find the mean pressure in the cylinder for various grades of expansion as derived in each case, from seven or nine diagrams, taken at varying speeds of from 16 to 55 miles per hour; and the latter enables us to find the mean loss of pressure between the boiler and the cylinder, from observations made by Messrs. Gouin and Lechâtelier in France, and by Mr. Gooch, and also by Mr. Clark, in this country. These observations show in the first place, that the decrease of pressure diminishes in proportion as the opening of the steam regulator is enlarged, up to a certain point corresponding to an area of $\frac{1}{20}$th that of the piston, when a further increase of opening is not accompanied by a corresponding increase of pressure; the fact just stated is so self-evident that it deserves to be mentioned only on the ground of its leading to the knowledge of the maximum useful opening of the regulator; it is fully appreciated also by engine drivers generally, who work their engines as much perhaps from the regulator handle as from the expansion gear proper. But as we intend to deal with the condition of maximum power chiefly, those observations only will serve our present purpose which have been taken with a maximum useful opening of the regulator; we have to regret, however, that their number is exceedingly small. The most comprehensive of the several series recorded by Mr. Clark, are those made by Mr. Gooch, which indicate, simultaneously, the pressures in the cylinder, the valve chest and the boiler; and though we find it difficult to believe, as stated by Mr. Gooch, that the pressure in the steam chest, was actually greater than that in the boiler, yet do they seem tolerably trustworthy in the final result which we are inquiring into. The mean loss of pressure computed from thirty-six observations is by them shown to be 9 per cent. of the initial pressure in the boiler, and the maximum loss is 17 per cent. of the same, occurring at a speed of forty-three miles per hour and with an admission of 30 per cent. of the stroke. Mr. Clark's observations show a fall of pressure between the steam chest and the cylinder, varying from 9 per cent. to 20 per cent., and those of Messrs. Gouin and Lechâtelier show a loss of 16 per cent. between the cylinder and the boiler, and a loss of 12 per cent. between the cylinder and the valve chest at speeds of 29 miles per hour.

From these figures we think that we may safely infer that a loss of 23 per cent. of the pressure in the boiler is all that need be reckoned upon for engines working under ordinary circumstances, although when there is heavy priming, that loss may amount to 60 per cent.; with this assumption and with the plate of indicator diagrams, above referred to, we have computed the following table of mean actual pressures in the cylinder for various grades of expansion, expressed in percentage of the pressure in the boiler; in the same table we give the mean pressure in pounds per square inch, for a pressure of 150lbs. in the boiler, the mean actual pressure in percentage of the maximum pressure in the cylinder and the relative efficiency of steam for the corresponding grades of expansion.

Admission in per centage of Stroke.	Mean actual pressure in cylinder in per cent of pressure in boiler.	Mean actual pressure for maximum pressure of 150 lbs. in boiler.	Mean actual pressure in cylinder in per cent. of maximum pressure in cylinder.	Relative efficiency of steam.
		lbs. per sq. in.		
100	77	115·5	100	1·00
74	71·5	107·25	92·33	1·30
66	69·5	104·25	89·70	1·415
49	60·0	90·00	77·50	1·711
40	49·1	73·65	63·40	1·916
30	41·9	62·85	54·10	2·200

This table will enable the reader to apply the general formulæ (9) and (6), to any particular case which, in practice, he may be called upon to solve, he having but to remember that for goods engines the pressure and the relative efficiency, corresponding to the long periods of admission, are to be taken, and for express, or passenger engines, those corresponding to the short periods of, say, from 40 to 50 per cent.

Cylinders are made of cast-iron and should be of a hard quality of metal, in order to wear long without requiring to be bored out afresh; in earlier days they were made invariably of from $\frac{3}{4}$ to 1in. metal in the body, but of late it has become a frequent practice to make them $1\frac{1}{4}$in. thick, in order chiefly to get as much wear as possible without lining them up; they are made long enough to leave a clearance of from $\frac{3}{8}$ to $\frac{1}{2}$in. at each end between the covers and the piston when it has reached the end of its stroke, and are bell mouthed at the ends to admit of being rebored without renewing the covers which invariably project some distance into them. These latter are ground true upon the ends of the cylinders and are bolted to them by means of stud bolts varying from 8 to 16 in number and from $\frac{3}{4}$ to 1in. diameter.

Some attempts to introduce wrought iron cylinders have been made, chiefly with a view to avoid breakages in the body of the cylinder, but without success. Should steel, however, become so cheap, as it is now predicted it will become by the aid of Bessemer's process, we may look forward to the day when they will be made of cast steel.

When the diameter of the cylinder and the stroke are decided upon, the next point to settle is the area and the shape of the steam ports, and as it has been stated that the useful opening of the regulator amounts to one-twentieth the area of the piston, it is clear at once that, so far as the admission is concerned, the area of the ports should not be less than this amount; experience, however, teaches that the great condition of economy in the locomotive engine is an easy and quick release of the steam behind the piston, and one of the means of realising this condition is to provide ample area in the steam ports, which, on that account, is made of from one-twelfth to one-fourteenth that of the piston.

It does not appear, at first sight, that the shape of the steam port has any influence upon the easy, and we may say the economic flow of the steam; but when it is remembered that the fall of pressure between cylinder and valve chest may amount to 20 per cent. of the whole pressure, considering the short distance over which the steam has to travel here, as compared with the length of pipe between the regulator and the steam chest, it behoves us to inquire into the causes of this loss of pressure which entails such a material loss of mechanical effect, and to see whether it is not in some measure attributable to the shape of the steam ports.

Morin's experiments upon the flow of steam in stationary engines are calculated to enlighten us upon this subject, and show that the loss of pressure varies:—

1. As the square of the speed of piston.
2. As the square of the ratio of area of piston to area of steam passage.
3. As a factor dependent on bends and friction.
4. They show also that friction is proportional directly to the length of the passage and to its periphery; that is for passages of equal extent in length, and of equal area, that one will occasion the smallest loss by friction whose cross section has the smallest periphery: to illustrate our meaning let us suppose that a steam passage of 16ins. area is required; this may be obtained by

A circle $4\frac{1}{2}$in. in diameter	having	a periphery	of 14.1in.
A square 4in. × 4in.	,,	,,	of 16·0in.
A parallelogram 7in. × $2\frac{3}{16}$in.	,,	,,	of 18·6in.
A ,, 11in. × $1\frac{7}{16}$in.	,,	,,	of 24·8in.
A ,, 12in. × $1\frac{5}{16}$in.	,,	,,	of 26·7in.

which table shows that for a given area the circle has the smallest periphery, that it increases as we pass from the circle to the square, and from the square to the parallelogram, until in the last case, which is not an uncommon size of port, it is nearly double that of the circle. It is true that various conditions of the problem lead to the shape of a rather elongated parallelogram, yet is it good to call the reader's attention upon this fact, and to point out the propriety of reducing the ratio between the two sides of the port as much as possible, since wire drawing, which is the loss of *energy* of the steam occasioned by the work of friction against the sides of the port, will be much less with a wide port and a great travel of valve, than with a narrow but long port, and a small travel of valve.

We have now reached that stage of our study when we are called upon to detail before our readers and to describe the mechanical contrivances by means of which the steam is distributed into the cylinders, and as the problem of an advantageous and economic evolution of the mechanical work stored up in the steam is centered almost exclusively in these parts of the machinery, which might very properly be called the heart of the engine, we shall trace the history of their developement from the earliest time of locomotive engineering in order to give a full illustration of the amount of ingenuity and patient thought which has been spent upon the subject ere it was solved in a satisfactory manner.

One of the first conditions of existence of the engine is an easy and sure means of reversing its motion upon the rails, or in other words of causing it to run either backward or forward at will; this was first done and still is done in many stationary and marine engines, by means of loose excentrics whose position upon the axle or crank shaft, in front or behind the crank, is determined by cams or catches fixed upon the shaft, the act of starting in reversing being accomplished by shifting the valve directly with hand gear. This system of loose eccentrics was found to be too cumbrous for locomotives where the available space is extremely limited, and at the same time it was too abrupt and easily deranged; for these reasons it was soon displaced by the more substantial plan known as Carmichael's valve gear

(Fig. 1, Plate 23), in which the eccentrics were fast upon the axles, and the eccentric rod ends were provided with a double fork intended to work in the studs of a double lever fixed upon the rocking or valve shaft; they were placed in forward or backward gear by means of a reversing shaft and levers which caused them to engage either the upper or lower stud, and thus the direction of tbe movement was readily changed by working one handle only; the forks were made wide enough to engage the studs in all positions of the valve, and Mr. Clark says that when the whole mechanism was well proportioned it preserved the lead of the valve both ways, or in other words, the fact of reversing the motion did not alter the relative position of crank and valve with regard to the periods of admission and release of steam. It seems, however, that this piece of mecbanism, though a great improvement upon the old method, was soon found to be defective in that very point of preserving the lead both ways, since it was superseded, in 1837, by the method of four eccentrics introduced first by Hawthorn, in which each valve is provided with two fixed eccentrics keyed respectively before and behind the crank. (Fig. 2) illustrates this method, as carried into practice by the Stephensons, in whose arrangement both eccentric rods were hung underneath the stud of the valve lever, and were raised and lowered simultaneously by being hung from two reversing shafts, placed symetrically in front and behind the centre of the working shaft, but worked by one reversing handle only. This arrangement bad the advantage of being self-balanced, and was worked very easily, though the presence of two reversing shafts was rather cumbrous. Sharp and Roberts' plan (Fig. 3) differed from Stephenson's, in that the forward and backward gabs were placed respectively above and below tbe stud of the valve rod lever, but still hung from two distinct reversing sbafts. This arrangement is scarcely an improvement upon tbe former, though it might have been a decided simplification of it by removing one of the reversing shafts, and it is to be wondered that the proverbial ingenuity of Mr. Roberts did not at once discover its superfluity here, as was afterwards done by Buddicom, of Rouen, whose valve gear is illustrated by (Fig. 4).

The problem of reversing the engine was now effectually solved and henceforward we find tbe ingenuity of man exerting itself to devise means for working the steam expansively.

The benefits of an increased lap and consequently of a slight expansive action, and an early release of tbe steam had been ascertained by practice upon the Liverpool and Manchester Railway since 1838, and the means of long and variable expansion were, therefore, at once sought in a considerable increase of the lap accompanied with variable travel of the valve. The first scheme which we meet with is John Gray's (Fig. 5) which was applied to some engines on the Liverpool and Manchester Railway in 1839. Here the eccentric rods were made to work in a slot lever, curved to tbe radius of tbe rods, and pivotting upon a fixed centre at one end, while the valve rod was attached to the other, and the travel of the valve was altered by raising or lowering the excentric rod; the engine was reversed, as before, by the use of two eccentrics wbich were thrown in and out of gear by means of a suitable arrangement of frames worked from one reversing handle, and made to engage into slot levers respectively commanding the forward and backward rods. This scheme, though it is cumbrous and complicated, and the action of reversing the engine difficult and abrupt, must be looked upon as tbe origin of the modern valve gear, for Williams' motion (Fig. 6) is a natural simplification of the former, but being impracticable in its arrangement, was finally put into its permanent and elegant shape (Fig. 7) by the Stephensons's, with whom, therefore, it may properly be said that the locomotive engine originated, and by whom it received its finishing touch.

Various schemes of valve gearing have been at different times proposed to supersede what is termed the Link motion, some of them with a pretence at simplification, and others with the object of improving the action of tbe valve with regard to variable expansion and release of steam; the greater part of them however have met with little or no success. Tbe objects of most attempts at simplification have been to dispense either with both or at any rate with one eccentric, and among tbese one of tbe most remarkable is Hawthorn's (illustrated by Fig. 8), in which the work of distributing the steam was performed by the connecting rod itself: a slide block was fixed to the latter in a suitable position of its length and was made to slide in a slotted link wbich transmitted the vertical motion of the block to the valve levers. The method of reversing was substantially the same as in Carmichael's gear, but the lead of the valve was regulated by giving the slotted link a certain incline either from the cylinders or towards them according as the engine was to run forward or backward; this very ingenious scheme was certainly much more difficult of adjustment than tbe method of two eccentrics and was much more complicated; on that ground also has it not met with much success although it yielded good results so far as regards the distribution of the steam.

In schemes for suppressing one eccentric, this object generally was attained by making the remaining eccentric movable either laterally in a helical groove, or transversely upon the axle, which was made square on that account; this however was only returning to the old method of loose eccentrics, long since condemned, and it is therefore no matter for wonder that its reprodnction in a somewhat altered shape should have met with no better success.

Tbe schemes of variable expansion generally consisted of two valves, it being the work of one valve to cut off the steam at various periods of the stroke, while the otber distributed it into the cylinder in the ordinary manner.

Among these is to be noted Meyer's expansion gear (Fig. 9) which was frequently applied to locomotives upon the continent,—before the good results obtained by the link motion were properly known,—and which is still very extensively used in stationary engines: here the distributing valve was provided with ports in the same way as the cylinder, and upon the back of it were two expansion blocks whose distance from each other was regulated from the outside by means of a rigbt and left handed screw, and which were put in motion sometimes by the cross head of the piston rod, sometimes by a distinct eccentric parallel witb the crank; when therefore the distributing valve was at the end of its travel, the expansion blocks were only in the middle of their travel, and the degree of expansion was varied by shifting them either from or towards the centre of tbe valve face by means of the screw before mentioned. The distributing valve was worked by the ordinary double eccentric and gab motion. This expansion gear accomplishes its intended object very well indeed, but has the disadvantage of requiring an amount of space which in locomotives cannot be well afforded, nor bas it the same claims to simplicity as the link motion, by which, for these reasons it has been superseded.

Before entering into the analysis of different kinds of link motions we will explain to our readers the general mode of distributing steam by means of the slide valve, and point out the defects of the old valve together with the means employed to remedy them, without however entering into a tedious explanation of technical nomenclature, the knowledge of which is now very generally diffused. The problem of distributing steam into a cylinder in order to communicate a reciprocating motion to tbe piston very naturally presents itself, at a first glance, in the following manner:—

1st. To let the steam enter the cylinder, when the piston has reached the end of its stroke, and to allow that steam, in front of which the piston is moving, to remain in the cylinder until the piston has reached the opposite end of the stroke, or in other words, to allow the entire volume of steam admitted to fill the extreme capacity of the cylinder.

2nd. To begin exhausting this steam just when the piston starts upon its return stroke, and to allow the exhaust to continue during the whole period of the return stroke.

It is easy to perceive from tbese conditions of the problem, that tbe admittance of steam at one end of the cylinder and the release of the steam which has done its work at the other end are two simultaneous events, and from inspection of the old valve diagram (Fig. 1, Plate 232) it will be perceived also that, under these circumstances, the valve faces just cover the steam ports witb only a nominal lap to make sure that the steam does not enter at both ends of the cylinder at tbe same moment; tbe valve also is at mid stroke when the piston is at the end of its stroke.

Practice however, as we have had occasion to mention already, soon revealed the fact that these are not the true conditions of the problem, if the engine is to perform its work efficiently and economically. Tbe complete exhaustion of the steam in the first place cannot be accomplished instantaneously, and since under the above conditions tbe exhaust is allowed to commence only when the piston begins its retrograde movement, the latter meets with an amount of back pressure seriously prejudicial to the economic interests of the engine; but if the steam were released sometime previous to the piston reaching tbe end of the stroke a great amount of back pressure would be avoided, though at the same time also a certain amount of useful work would be lost, owing to the untimely fall of pressure occasioned by this early release of the steam, and the question presents itself, does the gain upon back pressure warrant the loss of useful work thus obtained?

The question could be readily answered from a comparison of indicator diagrams taken from engines working respectively with the old and the modern valve, but the fact of the gain seems to be so evident that even Mr. Clark, who enters very minutely into the behaviour of steam in the cylinder, has not deemed it necessary to draw this comparison for the satisfaction of the minds of his readers, and the only means at our disposal to establish the desired parallel, is a record of the comparative consumption of fuel with progressive modifications of the valve, a summary of which we reproduce in tbe subjoined table.

Gross average consumption of coke per mile.

49 lbs.	old valve $\frac{1}{16}$ lap 1839.
36 lbs.	valves with $\frac{3}{8}$in. lap.
32 lbs.	valves with $\frac{3}{4}$in. lap.
28 lbs.	valves with 1in. lap.
22 lbs.	ditto ditto*

* With increased care in fixing.

The reduction in the consumption of fuel here shown, however, is not solely due to the reduction of back pressure, but arises also from the other sources of gain which we yet have to enumerate.

Another consequence of the construction of the old valve was that the steam was allowed to flow into the cylinder during the whole period of the stroke, and hence the benefits of the expansive properties of steam were lost altogether, although they had not remained unknown and were largely realised in the stationary engine. By inspection of the diagram the valve with one inch lap (Fig. 2, Plate 232), it will be seen that the steam works expansively during a period of three-elevenths of the stroke and the relative efficiency of steam at this degree of expansion is 1·32 which, in a great measure, accounts for the saving of fuel recorded in the above table. It will be seen also from the diagram that the steam is released at a period of two-twentieths of the stroke, which gives it sufficient time to clear the cylinder by the time the piston has reached the end of the stroke. Finally the valve is given a slight amount of lead varying from one-quarter to three-eighths, to admit the steam a short time before the piston has reached the end of the stroke with the object of filling the steam ways and of providing a spring, against which the momentum of the parts of machinery in motion wastes itself, thus deadening the shock which would inevitably be occasioned by any play which may exist between them, and avoiding their undue wear and untimely destruction.

(*To be continued*).

USEFUL NOTES AND FORMULÆ FOR ENGINEERS.

(*Continued from page* 269, December, 1862.)

SECTION VIII.

In this section we purpose treating of the flow of water, under various circumstances, to the end that we may deduce from our investigations formulæ which may be applied to practical purposes; as the construction of canals, weirs, pipes, etc.

The weight of water is taken at 10lbs. to the gallon, or 62·5lbs. or 1000 ounces per cubic foot, we shall, however, use only the cubic foot in this treatise.

The measure of gravity, although it varies slightly for different parts of the earth's surface, is usually taken at 32·182ft., this being the velocities acquired by a heavy body after falling freely for one second, the space through which it falls in the first second being equal to 12,091ft., and the above measure of gravity is denoted by 1.

According to the principles of uniformly accelerated motion, the velocity acquired during the fall of a heavy body are as the times occupied in acquiring them.

Let v = the velocity acquired.
t = the time occupied.
g = the velocity acquired in one second.

Then

$$v = g\,t,$$

also the spaces passed through are as the squares of the times occupied in passing through them.

Let h = height of fall.
t = time occupied in falling.
$\frac{1}{2}g$ = space fallen through in one second.

Then

$$h = \frac{g\,t^2}{2}$$

taking the value of b from this equation, and substituting it in the first we have,—

$$v = \sqrt{2\,h\,g} \text{ and } h = \frac{v^2}{2\,g}$$

since

$$g = 32{\cdot}182 \text{ feet}$$

$$\sqrt{2g} = 8{\cdot}0227$$

and

$$\frac{1}{2\,g} = 0{\cdot}15536$$

consequently,

$$v = 8{\cdot}0227\sqrt{h}$$

and

$$h = 0{\cdot}015536\,v^2$$

GENERAL PRINCIPLES OF THE FLOW OF WATER.

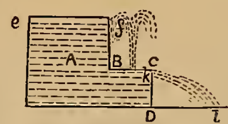


FIG. 36.

Let A (Fig. 36) be a vessel kept constantly full of water up to $e\,f$.

If an orifice is made in the horizontal surface B C, the fluid will pass out as a vertical which will rise to nearly the level of $e\ f$, and it would be quite that level were it not for certain retarding influences, as the resistance of the air, etc.

By the first principle of dynamics, in order that a body may rise vertically to a certain height, the velocity imparted to it, at starting, must be equal to that which it would have acquired in falling freely through the same distance. Therefore as the fluid particles, which pass out at the orifice in B C, are raised to the height B f, they must have velocities due to that height, which is the height of the water in the reservoir, above the orifice.

In like manner, if an orifice k be made on a vertical face, the velocity of exit of the particles will be found from certain relations between the lines D k, D l, to be that due to the height $k\ f$, and it would pass out with a velocity due to D f, if an orifice were opened in the bottom of the vessel.

If we call v the velocity of issue, and H the height of the water level above the orifice, we shall have,

$$v = \sqrt{2\,g\,h}$$

We have seen that the water does not quite attain the level of water in the reservoir, and if a tube was fitted to the orifice it would rise still less high.

Let n be the ratio between the height of the jet, and that of the reservoir for a tube of a certain form, H and H′ two heights of the reservoir and v, v' the corresponding velocities, then,

$$v = \sqrt{2\,g\,n\,\text{H}}, \text{ and } v' = \sqrt{2\,g\,n\,\text{H}'}$$

whence,

$$v : v' :: \sqrt{\text{H}} : \sqrt{\text{H}'}$$

that is to say, the orifices being of the same form the velocities are as the square roots of the heads.

This law applies to fluids of all kinds, such as oil, mercury, and the aeriform, so that the velocity, with which each of them passes over, is independent of its nature and density, and depends only on the head.

To the pressure which a fluid contained in a vessel exerts by its own weight on the orifice, may be added that of a foreign pressure, let this pressure be produced by a body P, acting on a surface s, then to find the additional head of water to which it is equal, replace it by a column of water of equal weight, having a base equal to s, the height of the column will be the additional head.

If we call h the head of water in the reservoir, and h' the additional head, the velocity will be,

$$= \sqrt{2\,g\,(h + h')}$$

We call the discharge of an orifice the volume of fluid which runs out of it in a second.

If the mean velocity were that which is due to the whole head, this velocity would be

$$= \sqrt{2\,g\,\text{H}}$$

if, at the same time, the particles passed out from all points of the orifice, and in parallel lines, the volume discharged would be equal to a prism, having the orifice for its base and the velocity for it height; it would be, calling S the area of the orifice,

$$= \text{S}\sqrt{2\,g\,\text{H}} \quad \ldots\ldots\ldots\ldots \text{(1)}$$

This is the theoretic discharge, but actual discharge is always less. This diminution of the discharge is produced in some cases by a diminution of the section of the prism of water, as in orifices in thin plates; in others it is produced by diminution of velocity, as in cylindrical tubes.

The actual discharge will in all cases be less than the theoretic, and to reduce the latter to the former, we must multiply it by a fraction. Let m represent this fraction; then, if Q is the quantity discharged,

$$\text{Q} = m\,\text{S}\sqrt{2\,g\,\text{H}} \quad \ldots\ldots\ldots\ldots \text{(2)}$$

and if Q^1 is the volume discharged in any number of seconds, N,

$$\text{Q}' = m\,\text{S}\,\text{N}\sqrt{2\,g\,\text{H}} \quad \ldots\ldots\ldots\ldots \text{(3)}$$

The diminution of discharge, whether it proceed from diminution of the

section or of the velocity of the vein, is always the consequence of the contraction which the vein experiences on passing through the orifice, wherefore m is called the co-efficient of contraction.

We will now show the cause of the contraction and its effects.

If we take a transparent vessel, having an aperture in one side through which the contained water is allowed to flow, and render the motion of the fluid particles visible by disseminating a substance of equal specific gravity in fine powder through the liquid, we shall find that after leaving the orifice, the water does not proceed in a cylindrical stream, but the particles approach the orifice from various directions, converging and passing through the aperture with an accelerated motion; the convergence of the particles of water causing a contraction without the orifice, $a\ b\ c\ d$ (Fig. 37) shows the form of the contracted vein, being a solid produced by the revolution of the curve $a\ c$ round the axis $e\ f$; $a\ b$ is the diameter of the orifice, $c\ d$ the diameter of the cylindrical stream after contraction, $e\ f$ the distance from the orifice to the section at which the stream becomes cylindrical; the values of these dimensions, found by actual measurement, are,

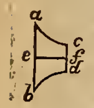


Fig. 37.

$$\text{If } a\ b = 1000.$$
$$c\ d = 787.$$
$$e\ f = 390.$$

from which we may obtain the co-efficient of contraction.

The ratio between the diameters before and after contraction being 0·787, the ratio between the sections will be the square of 0·787 or 0·619, which will be the value of m; substituting this in equation (2), we have,

$$Q = 0{\cdot}619\ S\ \sqrt{2\,g\,H} \quad\ldots\ldots\ldots\ldots\ (4)$$

This value of m is very near the truth, as indicated by experiment.

Flow through Orifices and Ajutages.

We will first consider the flow through an orifice in a thin partition. The co-efficient of reduction of the theoretic to the actual discharge is determined by measuring the volume of water discharged in a given time, and comparing it with the calculated discharge.

The greatest co-efficient obtained from a number of experiments by Castel and others on circular tubes was 0·692, and the least 0·617; on square orifices the maximum co-efficient was 0·655, and the minimum 0·616. We have hitherto considered that the fluid arrives equally at all parts of the orifice, but it is not always so; for instance, if the aperture be at the bottom of a vertical side, and its lower in the plane of the bottom of the reservoir, the contraction is destroyed on that side, and the discharge is greater.

Some experiments have been made by M. Bidone for the purpose of ascertaining the increment of discharge corresponding to partial destruction of the contraction, the mean of the experiments giving for the increment of discharge that of the free orifice being taken as unity,

$$1 + 0{\cdot}152\ \frac{n}{p}$$

in which n represents the length of the perimeter at which the contraction is suppressed, and p the length of the whole perimeter.

The greatest error of this formula was $\frac{1}{35}$, we may, therefore, adopt for the value of the discharge from rectangular orifices, when the contraction is suppressed on a part of the perimeter,

$$Q = m\,S\ \sqrt{2\,g\,H}\left(1 + 0{\cdot}152\ \frac{n}{p}\right) \quad\ldots\ldots\ldots\ (5)$$

for square orifices.

The mean of the experiments on circular orifices gives,

$$Q = m\,S\ \sqrt{2\,g\,H}\left((1 + 0{\cdot}128\ \frac{n}{p}\right) \quad\ldots\ldots\ldots\ (6)$$

Interior tubes reduce the co-efficient of contraction very considerably on account of the effluent particles approaching the orifice in more opposite directions than in the case of an orifice in a thin plate; Borda by means of an interior tube so arranged that the effluent water in no way touched the sides of the tube, reduced the co-efficient of contraction to 0·515.

The limits of the co-efficient of contraction for orifices of all kinds, with or without ajutages will be, 1 and 0·50, which may be approached very nearly but never attained, for orifices in a plane side they seldom descend below 0·60, or rise above 0·70, and in practice they are usually confined between 0·60 and 0·64; as a mean approximate term 0·62 is generally taken, whence we have for a circular orifice, whose diameter is represented by d,

$$Q = 0{\cdot}62\ S\ \sqrt{2\,g\,h}$$
$$= 3{\cdot}9066\ d^2\ \sqrt{H} \quad\ldots\ldots\ldots\ldots\ (7)$$

We may ascertain the real velocity of discharge under any head by measuring the height to which the fluid will rise vertically, and if h be the height to which it rises, the velocity at the orifice will be

$$\sqrt{2\,g\,h}$$

if H is the head of water in the reservoir, h differs from H, 1, 2, 3, &c., hundredths of the square of its value, according as H is 1, 2, 3, &c., and the velocities being as the square roots of the heights, the actual velocities will differ in the same cases only 1, 2, 3, &c. half hundredths of the theoretical velocity.

Another method of determining the actual velocity indicates still less difference, it is as follows:—

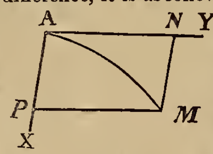


Fig. 38.

When a body is thrown in any direction A Y (Fig. 38) with a certain velocity, by the combined influence of that force and of gravity it describes the curve A M, if the velocity and consequently the resistance of the air is not very great, that curve is a parabola. If v is the velocity with which the body is impelled along A Y, and t the time which would be occupied in reaching N if no other force acted upon it, the motion would be uniform, and we should have $A\,N = t\ v$. If, on the other hand, the force of gravity had acted alone, it would have descended from A to P, and we should have had

$$A\,P = \frac{g\,t^2}{2}$$

Complete the parallelogram A P MN; at the end of the same time it wil arrive at M, having described the arc A M, $A\,P = x$ will be its abscissa, and $M\,P = y$ will be its ordinate, then

$$x = \frac{g\,t^2}{2}$$

and

$$y = v\,t,$$

taking the value of t from the latter equation and substituting it in the first, we have,

$$x = \frac{g\,y^2}{2\,v^2}$$

or

$$y^2 = \frac{2\,v^2\,x}{g},$$

or calling h the height due to the velocity v, and remembering that

$$\frac{v^2}{2\,g} = h$$

$$y = 4\,h\,x$$

an equation to a parabola, of which $4\,h$ is the parameter. Hence a heavy body impelled by any force of projection, describes a parabola whose parameter is four times the height due to the velocity of projection.

This law applies to jets of water as well as to solid bodies, and determining the actual velocity by this method. Bossut found the ratio of the actual to the theoretic velocity in two experiments to be 0·974, and 0·980; Michellotti found it, in three experiments, to be 0·993, 0·988, and 0·983. The difference between the two velocities increases with the head, and it should be so, as the cause of this difference, the resistance of the air, varies as the square of the velocity, and consequently nearly as the head.

If the water contained in the reservoir instead of being at rest, were moved towards the orifice with a velocity u, we should have

$$Q = m\,S\ \sqrt{2\,g\left(h + \frac{u^2}{2\,g}\right)} = m\,S\ \sqrt{2\,g\,h + u^2} \quad\ldots\ldots\ldots\ (8)$$

We will now consider the flow of water through ajutages. Cylindrical ajutages give a greater discharge than orifices in a thin side, provided the length of the ajutage exceeds the length of the contracted vein; it should be two or three times the diameter. Under these circumstances the vein after contraction, expands and fills the passage being attracted by the sides of the tube.

The diminution of the actual discharge is caused by diminution of velocity, and the mean coefficient is 0·82, thus,

$$Q = 0{\cdot}82\ S\ \sqrt{2\,g\,H} = 5{\cdot}1668\ d^2\ \sqrt{H} \quad\ldots\ldots\ldots\ldots\ (9)$$

The discharge through converging conical ajutages is greater than the preceding, although a contraction takes place without the tube.

The angle of convergence corresponding to the greatest discharge is from 13° to 14°.

The co-efficient of discharge which corresponds to the angle 13°, is about 0·953.

Conical diverging ajutages give the greatest discharge, but as they are but little used, we shall pass over them, although they present some interesting phenomena.

FLOW OF WATER UNDER VERY SMALL HEADS.

When the head over the centre of the orifice is very small, compared with the height of the orifice, the mean velocity of the fluid vein, or the velocity by which the area of the orifice is to be multiplied to give the discharge, is not that of the centre line of the vein.

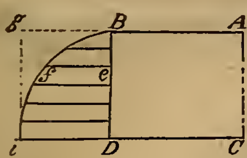


FIG. 39.

Let A B C D (Fig. 39,) represent a vessel kept full of water; and let there be in the vertical face B D, a series of very small apertures, of which D is the lowest. Let H equal the height B D, then the velocity of the particles passing out at D,

$$= \sqrt{2\,g\,H}$$

and if D i be made equal to that quantity it will represent the velocity. For any other point e, whose distance below the level of the reservoir is B e, or x, the line $e\,f$ or y will represent the velocity, so that

$$y = \sqrt{2\,g\,x}$$

or

$$y^2 = 2\,g\,x,$$

which is the equation of a parabola whose parameter is $2g$.

Suppose now that instead of a number of small openings in the face B D there had been a rectangular slit whose breadth is b, it is evident the discharge will be equal to the prism having b for its length, and the parabolic segment B f i D for its base.

According to the properties of the parabola, the parabolic segment is equal to two thirds of the rectangle B g i D, which rectangle is equal to H $\times$ b; the discharge through the rectangular slit will therefore be

$$= \tfrac{2}{3}\,b\,H\sqrt{2\,g\,H} \quad \ldots\ldots\ldots\ldots \quad (10)$$

The discharge through a similar slit whose height is D e, will evidently be equal to the difference between the discharges when the heights of the slits are H and B e, call this latter h, then the discharge,

$$= \tfrac{2}{3}\,b\sqrt{2\,g}\,\left(H\sqrt{H} - h\sqrt{h}\right) \quad \ldots\ldots\ldots \quad (11)$$

these equations give the theoretic discharge, and to reduce them to the actual discharge they must be multiplied by the co-efficient of contraction, which in this case varies from 0·60 to 0·70.

FLOW OF WATER OVER WEIRS.

Let there be made a rectangular opening B C (Fig. 40) at the top of the basin A B C D, the basin being kept constantly full of water; this opening is called a weir.

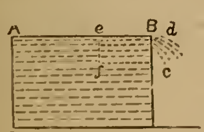


FIG. 40.

The surface of the water before reaching the weir, and starting from a point e, is inclined along the arc $c\,d$; so that its height above the sill will not be B c, but d c. If we follow this investigation it will lead to the conclusion that discharge would be the same as in the case of a rectangular orifice, whose upper edge is at d, the water level being continued to B without inflection; it is, however, more correct to consider the discharge as proceeding from a rectangular orifice, whose height is equal to f e or B c; hence we have from equation 10 (p)—

$$Q = \frac{2}{3}\,b\,H\sqrt{2\,g\,H}$$

for the theoretic discharge; or

$$Q = \frac{2}{3}\,b\,H\,m\sqrt{2\,g\,H}$$

$$= 5{\cdot}3484\,m\,b\,H\sqrt{H} \quad \ldots\ldots\ldots\ldots \quad (12)$$

for the actual discharge.

We have hitherto considered the water to be at rest above the weir, but it very frequently happens that it arrives at the weir with a certain velocity. Let u represent the velocity of arrival; 0·0155 u^2 will be the height due to that velocity, and we shall have for the real velocity at the exit—

$$\sqrt{2\,g\left(\frac{4}{9}\,H + 0{\cdot}015536\,u^2\right)}$$

and consequently,

$$Q = 5{\cdot}3484\,m\,b\,H\sqrt{H + 0{\cdot}035\,u^2} \quad \ldots\ldots\ldots\ldots \quad (13)$$

In some experiments upon the flow over weirs, the value of m varied from about 0·60 to 0·70.

MOTION OF WATER IN CANALS.

Gravity is the sole force that acts upon a mass of water left to itself in a bed of any form; so that as long as the surface of the water is horizontal no motion will take place; but if the surface is at all inclined, motion will immediately take place. Hence the principle that the motion of particles in a watercourse is due wholly to the slope at the surface, and it is this slope which enables gravity to act.

If the surface of the water in a canal makes an angle a with the horizon, that part of the gravitating force which causes motion will be represented by

$$g \sin. a$$

which will be the velocity acquired in one second. This velocity will continually increase if no other resistance is met with; this, however, is not the case, for the motion becomes uniform after a very short time.

We will now consider the nature of the resistance which produces this phenomenon. When water passes over the surface of a body, there being no repulsion between the two substances, it wets the surface—that is to say, a thin layer of water is attracted and retained, the particles of which again attract the passing particles of water, retarding their motion; and this attraction extends to the centre lines of particles, but continually decreasing from the perimeter to the centre. This constitutes fluid friction, which is independent of the pressure of the water, being proportional to the wetted surface, and also to a quantity depending upon the velocity. The friction will be influenced by the velocity in two ways: first, the force with which the particles are attracted will be as the velocity, and the number attracted will also be as the velocity, the total retardation being as the square of the velocity. This would give $a\,v^2$ for the retarding influence, a being a constant to be found by experiment; but practice shows that the expression

$$a'\,(v^2 + b\,v)$$

will be a nearer approach to the truth. Besides the two quantities already named as regulating the retardation, it is affected by a third, the section area of the stream, to which it is inversely proportional; therefore the total resistance

$$= \frac{c}{S}\,a\,(v^2 + b\,v)$$

in which c represents the contour, s the sectional area, and a b are constants. We have for the value of a and b, from very extensive observations of Eytelwein on canals and rivers,

$$a = 0{\cdot}0035855$$

$$b = 0{\cdot}217785$$

As the value of $a\,b\,v$ will be very small, it may be omitted in practice, and the resistance considered as

$$= \frac{c}{S}\,a\,v^2$$

To find the velocity we must equate the accelerating to the retarding forces; the accelerating force is equal to the sine of the angle of inclination multiplied by the force of gravity; the retarding force is the resistance of friction; therefore if

h = height of level of one point of the canal above any other.
l = distance between these points.
c = wetted perimeter.
s = sectional area.

$$\frac{h}{l} \times g = a \times \frac{c}{s} \times v^2$$

$$v^2 = \frac{g}{a} \times \frac{s}{c} \times \frac{h}{l}$$

but,

$$\frac{g}{a} = 10{,}000$$

therefore,

$$v = 100\sqrt{\frac{h}{l} \times \frac{s}{c}}$$

v being the velocity at the lower point; the quantity of water delivered at this point will be

$$Q = 100\,s\sqrt{\frac{h}{l} \times \frac{s}{c}} \quad \text{.......................... (14)}$$

Motion of Water in Pipes.

We here consider the case of closed pipes such as are used for conducting water from one place to another; these conduit pipes usually run full under the pressure.

The motion of water in pipes is similar to that in canals, and the formula (equation 14),

$$Q = 100\,s\sqrt{\frac{h}{l} \times \frac{s}{c}}$$

will apply to the discharge; but for pipes running full

$$s = d^2 \times {\cdot}7854$$

$$c = d \times 3{\cdot}1416$$

$$\therefore \frac{s}{c} = \frac{d^2 \times {\cdot}7854}{d \times 3{\cdot}1416} = \frac{d}{4},$$

in which d is the diameter,

$$\therefore Q = 38{\cdot}27\sqrt{\frac{h}{l} \times d^5}$$

which is the discharge in cubic feet per second: although we have throughout given the discharges in cubic feet per second we shall, in this case furnish the value of the discharge per minute;

Let Q' = discharge in cubic feet per minute.

$$Q' = 2356\sqrt{\frac{h}{l} \times d^5} \quad \text{..................... (15)}$$

or stating it in logarithms,

$$\log. Q' = \frac{1}{2}\left\{6{\cdot}744 + \log. h + 5\log. d - \log l\right\}$$

These formulæ do not take the resistance of bends into consideration; we will therefore proceed to the investigation of this kind of resistance.

Let a stream of water be proceeding in the direction A B (Fig. 41) and at the point B let there be a sudden change in the direction of the conduit; then draw A D at right angles to C D, the direction in which the stream will be turned, and let the angle A B D be represented by α; then if A B represent the velocity of the stream when it arrives at B, the velocity in the direction C B will be

Fig. 41.

$$= v\cos.\alpha = BD$$

the loss will evidently be represented by the difference between the velocities before and after passing the point B, or by

$$AB - BD = v - v\cos.\alpha$$

$$= v(1 - \cos.\alpha) = v\ \text{versin.}\ \alpha$$

Hence the loss caused by a sudden bend, is that represented by the versine of the angle made by the two directions.

In the case of a circular bend the loss of velocity is extremely small, as the particles running close to the sides of the tubes suffer no loss; although the centre lines of particles will be reflected from side to side of the tube all round the curve. From experiments on the resistance of curved bends, Dubuat concluded, that the value of that resistance is proportional to the square of the velocity, to the number of angles of reflexion and to the squares of their sines, the mean co-efficient 0·00375. So that if v be the velocity, n, n^1, &c., the number of the angles of the same magnitude, α, α^1 the magnitudes of the angles, the resistance will be

$$= 0{\cdot}00375\,v^2\,(n\sin.^2\alpha + n^1\sin.^2\alpha^1 + \ldots .)$$

or, s^2 being the sum of the squares of all the sines, and D the diameter of the pipes

$$= 0{\cdot}006079\,\frac{Q^2}{D^4}\,s^2$$

A resistance, and consequently a reduction of velocity and discharge will be produced by sudden enlargements or contractions of the conduit; however, as the conduit should not have enlargements or contractions, and as the formulæ for the resistance opposed by them, are not satisfactory we shall not give formulæ for the value of this resistance.

ERICSSON'S "MONITOR."

Most of our readers are doubtless aware of the *Monitor* having been totally lost (the details of the loss will be found in another column). The accompanying illustrations, figures 1 and 2, represent this ill-fated vessel as designed and constructed by Capt. Ericsson, without the extra plating afterwards added. Figure 1 being a side elevational view, and fig. 2 a transverse section to an enlarged scale through centre of the revolving cupola.

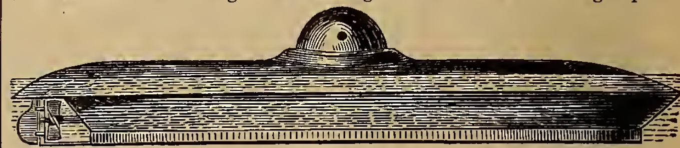


Fig. 1.

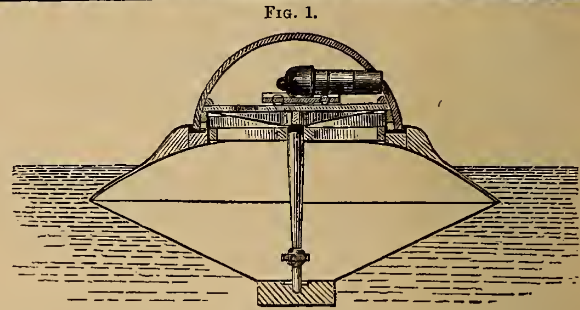


Fig. 2.

We will not here enter a discussion of the merits of the rival claims of Capt. Ericsson and Capt. Coles as to the originality in the invention of this class of vessels and the cupola; as though, doubtless, Capt. Coles may possibly deserve some credit for endeavouring to *improve* upon Ericsson, still that the originality of design of the *Monitor* is due to Ericsson, we think there can be no doubt whatever.

The following is an extract of a communication from Capt. Ericsson upon the subject of this invention, and forwarded to the Emperor of the French in September, 1854.

"*New System of Naval Attack.*—The vessel to be composed entirely of iron. The midship section is triangular, with a broad, hollow keel, loaded to balance the heavy upper works. The ends of the vessel are moderately sharp. The deck, made of plate iron, is curved both longitudinally and transversely with a spring of 5 feet; it is made to project 8 feet over the rudder and propeller. The entire deck is covered with a lining of sheet iron, 3 inches thick, with an opening in the centre 16ft. diameter. This opening is covered by a semi-globular turret of plate iron, 6 inches thick, revolving on a column and pivot by means of steam power and appropriate gear work. The vessel is propelled by a powerful steam engine and screw propeller. Air for the combustion in the boilers and for ventilation within the vessel, is supplied by a large self-acting centrifugal blower, the fresh air being drawn in through numerous small holes in the turret. The products of the combustion and impure air from the vessel are forced out through conductors leading to a cluster of small holes in the deck and turret. Surrounding objects are viewed through small holes at appropriate places. Reflecting telescopes, capable of being protruded or withdrawn at pleasure, also afford a distinct view of surrounding objects. The rudder stock passes through a water-tight stuffing-box so as to admit of the helm beng worked within the vessel. Shot striking the deck are deflected, whilst shell exploding on it will prove harmless. Shot (of cast iron) striking the globular turret, will crumble to pieces or are deflected. This new system of naval attack will place an entire fleet of sailing ships, during calms and light winds, at the mercy of a single craft. 'Boarding,' as a means of defence, will be impracticable, since the turret guns, which turn like the spokes in a wheel, commanding every point of the compass at once, may keep off and destroy any number of boats by firing slugs and combustibles. A fleet at anchor might be fired and put in a sinking condition before enabled to get under weigh. Of what avail would be the 'steam guard ships' if attacked on the new system? Alas for the 'wooden walls' that formerly 'ruled the waves.' The long range Lancaster gun would scarely hit the revolving iron turret once in six hours, and then, six chances to one, its shot or shell would be deflected by the varying angles of the face of the impregnable globe. When ultimately struck at right angles, the globe, which weighs upwards of 40 tons, will be less affected by the shock than a heavy anvil by the blow of a light hammer; consequently, the shot would crumble to pieces, whilst the *shell* would strew the arched deck with harmless fragments. During contest the revolving turret should be kept in motion, the port-holes being turned away from the opponent except at the moment of discharge, which, however, should be made during full rotation, as the lateral aim in close quarters requires but little precision."

ABSTRACT OF ENGINEER'S LOG OF THE "GREAT EASTERN." VOYAGE FROM NEW YORK TO LIVERPOOL, JANUARY, 1863.

Date each day, ending at Noon.	PADDLE ENGINES. Revolutions of Engines each day.	PADDLE ENGINES. Average Revolutions per minute.	PADDLE ENGINES. Average Pressure of Stm. in Engine-room.	PADDLE ENGINES. Tons of Coal used each day.	SCREW ENGINES. Revolutions of Engines each day.	SCREW ENGINES. Average Revolutions per minute.	SCREW ENGINES. Average Pressure of Stm. in Engine-room.	SCREW ENGINES. Tons of Coal used each day.	Total quantity of Coal used each day.	Number of Knots run by Paddle Engines.	Number of Knots run by Screw Engines.	Distance run by Ship in Knots.	Latitude.	Longitude.	Course.	Barometer.	Observations on Rolling of Ship. Inclination to windw.	Observations on Rolling of Ship. Inclination to leeward	Observations on Rolling of Ship. No. of oscil. per min.	General Remarks.
			lbs.	Tons			lbs.	Tons	Tons	K.	K.	K.				inches.	deg.	deg.		
Jan. 5 ...	912	9·0	19	20	4,100	31·0	16	25	45	26	28	22	Steering by the land.			...	0	0	0	At 10 A.M. started engines ahead full speed. At 10.50 A.M. stopped engines to discharge pilot and stevedores men. At 11 A.M. started engines ahead full speed.
Jan. 6 ..	12,960	9·0	22	120	43,760	31·0	17	150	270	317	319	245	40·50 N.	68·10 W.	Various.	29·51	0	0	0	At 7.30 P.M. stopped engines to discharge pilot off Montauk point. At 7.45 P.M. full speed.
Jan. 7 ...	12,393	9·0	20	136	45,480	32·2	17	156	292	314	325	265	43·41 N.	63·9 W.	N. E. by E. ¾ E.	29·60	7	8	6	Strong wind and heavy sea running; square sails set.
Jan. 8 ..	11,485	8·5	19½	126	43,820	32·0	17	144	270	300	320	275	45·30 N.	58·19 W.	E. ¾ N.	30·19	6	7	4	Stopped screw engines 1 hour and 30 minutes to repair brasses of crank in tunnel.
Jan. 9 ..	12,231	9·0	20	134	44,940	32·6	17½	150	284	311	325	248	46·26 N.	52·12 W.	E. by N. ½ N.	30·41	3	5	5	Stopped paddle and screw engines 45 minutes to take soundings.
Jan. 10 ...	12,630	9·0	20	126	44,060	32·0	16	147	273	315	325	260	47·49 N.	46·4 W.	E. N. E.	30·27	3	5	6	Stopped paddle and screw engines 20 minutes to put a corpse over board.
Jan. 11 ...	11,692	9·0	20	118	44,580	32·0	16	148	266	313	323	264	48·20 N.	39·12 W.	E. ¾ N.	30·31	7	9	5½	Strong beam wind and heavy sea; fore and sails set.
Jan. 12 ...	12,568	8·9	20	124	46,260	32·6	17½	152	276	300	329	266	49·42 N.	33·19 W.	E.N. by ½ N.	30·37	5	7	5	Light fair wind; square sails set.
Jan. 13 ...	13,484	9·6	20	139	46,670	33·3	17½	160	299	330	333	270	50·20 N.	26·30 W.	E. ¾ N.	30·41	4	5½	5	Light fair wind; square sails set.
Jan. 14 ...	13,821	9·7	20	141	46,680	33·0	17½	158	299	341	339	290	51·10 N.	18·49 W.	E. ½ N.	30·57	3	4	5	Light head wind; swept tubes of paddle boilers.
Jan. 15 ...	14,085	10·0	20	140	47,060	33·4	17½	160	300	350	340	280	51·12 N.	11·32 W.	E.	30·60	2	3	4½	Light head wind; swept tubes of screw boilers.
Jan. 16 ...	14,251	10·0	20	134	46,210	33·7	17½	155	289	350	333	300	52·56 N.	5·20 W.	Various.	30·80	0	0	0	Light head wind; sea smooth.
Jan. 17 ...	5,616	11·0	20	56	18,320	35·0	17½	62	118	128	120	93	Steering by the land.			30·50	0	0	0	Strong head wind; sea smooth. At 5.20 P.M. stopped paddle and screw engines. At 6.35 P.M. stopped paddle and screw engines to take pilot on board. At 7. P.M. started paddle and screw engines ahead half speed. At 8.45 P.M. arrived off Bell Buoy.
Total	148,158	9·3	20	1514	521,940	32·6	17·25	1767	3281	3695	3759	3078	...	...	...	...	...	...	...	Actual time steaming, 11 days, 3 hours. All particulars of engines taken up to this time.

Indicator out of order; density of water in boilers 1⅝; vacuum in paddle engines, 25; vacuum in screw engines, 25; extreme diameter of paddle wheels, 50 ft.; effective diameter 48ft. = 150·79 ft. each revolution; pitch of screw, 44ft.; average distance run per hour 11·52 knots; immersion on leaving New York, 25 ft. 2 in. forward, 29 ft. 11 in. aft.; immersion on arrival at Liverpool, 21 ft. 3 in. forward, 28 ft. 6 in. aft.; slip of paddle wheels 20·4 per cent.; slip of screw, 22·12 per cent.; average daily consumption of coal by paddle engines, 136·8 tons; ditto by screw engines, 158 tons; total daily consumption, 294·8 tons. (Signed) J. RORISON, Chief Engineer.

INSTITUTION OF CIVIL ENGINEERS.

ON THE HOWNES GILL VIADUCT, ON THE STOCKTON AND DARLINGTON RAILWAY.

By Mr. W. Cudworth, M. Inst. C.E.

This viaduct was situated near to the Consett Ironworks of the Derwent Iron Company, in the north-western part of the county of Durham, on what was formerly the Stanhope and Tyne Railway, an undertaking which came into the hands of the Stockton and Darlington Railway Company in the year 1844. Hownes Gill was a dry ravine 800ft. in width and 160ft. in depth, and originally the line was laid out with gradients corresponding with the natural contour of the ground, that on the west side being 1 in 2½ and that on the east side 1 in 3. The traffic was conveyed over these gradients for some years with little difficulty; but a large accession of of trade, due mainly to the discovery of the Cleveland ironstone, rendered greater facilities of transit imperative. It then became apparent, that the erection of a high level viaduct was indispensable; and as early as the year 1844, the Directors of the Stockton and Darlington Railway Company took steps with the view of ascertaining the probable cost of such a structure. It was not, however, until December, 1856, that a contract was entered into with Mr. John Anderson, to erect a viaduct of firebrick set in hydraulic mortar and the arches in cement, in eighteen months, and to uphold it for twelve months after completion, for the sum of £14,614. The design was prepared by Mr. T. Bouch (M. Inst. C.E.), and was subsequently approved, with some modifications, by the late Mr. R. Stephenson and Mr. G. P. Bidder.

The extreme length of the viaduct was 730ft., and its greatest height from the bottom of the inverts to the level of the rails 162ft. It had twelve semi-circular brick arches, each 50ft. span, 14ft. in length, and 2ft. 6in. in thickness. The inverted arches in the foundations, four in number, which were introduced, at the suggestion of Mr. Stephenson, so as to extend the bases of the three central piers until the weight scarcely exceeded 1 ton per superficial foot, had a versed sine of 14ft., were 38ft. in length, and 3ft. in thickness. The extreme height of the five loftiest piers, measured from the springing of the inverts to the springing of the arches, ranged from 114 to 110ft.; that of the six remaining piers diminished rapidly towards each end. Their length was 14ft. at the top, and 38ft. at the bottom, the latter dimension corresponding with that of the inverts. The piers, to within 15ft. of the inverts, were stayed by buttresses transversely to the line of the viaduct. At this point they were only 17ft. 6in. in length, but below this level the buttresses merged into the piers, when they together had a rectangular section 38ft. in length. The buttresses were 3ft. thick at the top, and 5ft. thick at the bottom; their projection from the piers being increased by offsets at intervals of 35ft. The piers, although light in their proportions, were reduced by recesses, 7ft. 3in. wide and averaging 3ft. 9in. deep, sunk in each side, so that the horizontal section of each pier with the buttresses was in the form of a double cross, the brickwork in the middle being only 2ft. thick. These recesses were not continuous, but were divided into three compartments in height, and by their adoption the amount of brickwork in each pier was reduced about 14½ per cent. Between the spandril walls, two internal parallel walls of stone were introduced to sustain a platform of flagging, on which the way beams and the ballast were carried. The way beams, which were of Memel timber, were at first secured to the internal walls by bolts; but as this plan was found to be objectionable, the nuts from the holding down bolts were removed, and a thickness of 6 inches of coke ballast was interposed between the way beams and the flagging. The parapet consisted of a substantial cast iron railing. The firebricks, which were of excellent quality, weighed 9lbs. 11ozs. each, and cost the contractor at the viaduct thirty-one shillings and twopence per thousand. The number used was 2,655,000. It was a gratifying fact that the work was completed without accident, and that not a single crack was to be found in the whole of the structure. The erection of the scaffolding, which was of a very light character, was considerably facilitated by the hoisting tackle being made to traverse a stout wire rope stretched across the gill, and firmly fixed at each side. When the arches were about to be turned, the piers were stayed by two parallel wire ropes stretched from end to end of the viaduct. The first brick was laid in February, 1857, and the first train passed over the viaduct in July, 1858. The cost of the structure amounted to £15,756, the contract sum having been increased by the additional depth of the foundations, by the adoption of a heavier

parapet, and by other contingencies. Regarding the viaduct as an unpierced solid, its contents would amount to 61,910 cubic yards, and its cost would be five shillings and one penny per cubic yard.

The question of the relative cost of brick and iron viaducts was then alluded to, reference being made to two works of the latter description erected by Mr. Bouch on the South Durham and Lancashire railway. These viaducts consisted of three lines of trellis girders resting upon skeleton piers, formed of six cast iron columns, jointed at intervals of 15ft., and braced together by horizontal cast iron struts, and by vertical and horizontal tie bars of wrought iron. The clear spans between the piers were in all cases 48ft. The Beelah viaduct was 1000ft. in length, and 197ft. in extreme height. The Deepdale viaduct more nearly resembled the Hownes Gill in its proportions, being 740ft. length and 160ft. in extreme height. A comparison was therefore instituted between the probable cost of such an iron viaduct erected across the Hownes Gill valley, and one of brickwork, supposing both to be built to carry a double line of railway, and that the spread of the foundations was in each case adjusted to sustain a weight of 2½ tons per superficial foot, including the greatest moving load. The prices of the brickwork and of the masonry were taken from Mr. Anderson's schedule; those of the timber and ironwork were the prices actually paid to Messrs. Gilkes, Wilson, and Co., the contractors for the South Durham and Lancashire viaducts, minus a deduction of ten shillings per ton for the cost of cartage over country roads. With this adjustment it was found that the cost of the viaducts, calculated in this way, would be £20,681 for the brick structure, and £16,249 for that of iron. It was thought probable that the interest on the difference between these two amounts, say £222 per annum, would be absorbed in the periodical examination and painting of the iron, and the depreciation of the perishable timber platform; and that at the place referred to a brick viaduct would be, ultimately at least, as cheap as one of iron. If the viaducts were designed to carry a single line of railway, the comparison would, it was believed, be still more in favour of brick. Although the author preferred brick or stone, he by no means regarded iron as ineligible under all circumstances. In situations which did not yield suitable building materials, and where there were no cheap means of conveyance from a distance, the small relative mass of an iron viaduct would be a strong argument in its favour; for the whole weight of such a structure, including masonry foundations, would be less than one-fifth that of brick. This circumstance would also conduce to the selection of iron in cases of doubtful foundations.

ON SOME OF THE INTERNAL DISTURBING FORCES OF LOCOMOTIVE ENGINES.

By Mr. A. W. Makinson, M. Inst. C.E.

The author stated that, although the Permanent Way of railways had been much improved of late years, it was still a question for inquiry, which was proposed to be undertaken in the present Paper, whether, having regard to the safe transit of passengers at the high speeds now demanded on trunk lines, the locomotive engines were as free as possible from such internal disturbing forces as had a tendency to cause them to leave the rails.

In elucidation of the subject, the indicator diagrams taken from the cylinder of the "Great Britain" locomotive on the Great Western Railway in 1847-49-50 (*vide* Clark's *Railway Machinery*) at the velocities of 26, 35, and 52 miles per hour respectively, were selected for examination; and from these a series of diagrams was constructed, which exhibited graphically the different forces acting in a locomotive when in motion, numerical values being assigned to each of those forces.

The disturbing forces were divided into two classes—first, those which were generated by the revolving parts of the engine, as the crank, crank-pin, and half the weight of the connecting-rod; and secondly, those which were generated by the reciprocating masses, as the piston, piston-rod, cross-head, and half the weight of the connecting-rod, &c. As it was understood that, in the practice of the first locomotive engine makers, the proper counterbalance for the revolving appendages was now always applied, that class was not considered.

The nature and origin of the second class of forces were then examined in detail. It was observed that, if the circular path of the crank-pin around the axle was divided vertically by a straight line through its centre, then the crank arm would approximately coincide with this line, when in its positions both of greatest and of least velocity; and while the crank-pin moved through 180°, from its position of the greatest to that of the least velocity, the reciprocating appendages developed pressures in favour of the motion of the train, but when it moved from the position of the least to that of the greatest velocity, these appendages offered resistances to the motion of the train. Again, it was shown that, in general terms, at every velocity the pressures generated by the *vis inertia* of the reciprocating parts were the greatest at the end of the stroke, and vanished at or near to the mid-stroke; the pressure during the second half of the forward stroke and the first half of the back stroke assisting the motion of the train, and during the second half of the back stroke and the first half of the forward stroke opposing the motion of the train.

It was only by adding the pressure thus developed by *vis inertia* to the simultaneous steam pressure, that the total efficient tractive power generated at any moment in either cylinder could be arrived at. The variation in amount of the tractive power, throughout one stroke of the piston, was thus seen to be much greater than when the steam pressures alone were considered. By adding together the amounts of tractive power simultaneously developed in the two cylinders of the ordinary engines, with cranks at right angles to each other, the total tractive force on the train at any point in one revolution of the driving-wheel, was arrived at; and the diagrams exhibited showed the great irregularity in amount of the total tractive force, operating to produce fore and aft motion in the engine and train. By comparing with each other the amounts of tractive force developed simultaneously in the two cylinders, the tendency to sinuous motion in the two-cylinder engine was shown, and exhibited graphically in one of the diagrams.

In conclusion, the author submitted that a single cylinder engine would be free from all sinuous motion: that at 26 miles an hour it would have about the same, and at higher speeds far less, fore and aft motion, than the ordinary two-cylinder engines; that by supplying the driver with the means of applying about as much power as was expended in putting the breaks on hard, a single-cylinder engine would have equal certainty of starting with the two-cylinder engine: and that the use of single-cylinder engines for passenger traffic would, by reducing the oscillation of the carriages, render railway travelling less unpleasant, and reduce the cost of locomotive power, and the expense of maintenance of way; whilst the dead weight of the engine, and the wear and tear of the several parts, would be diminished.

The appendix contained mathematical investigations and formulæ showing: 1st, the relation between the pressure on the piston, as observed by the indicator, and the equivalent pressure at the crank-pin; 2nd, the disturbing force generated by the unbalanced revolving masses; and 3rd, the pressures, referred to the crank-pin, generated by the *vis inertia* and varying velocity of the reciprocating parts of a locomotive in motion.

INSTITUTION OF ENGINEERS IN SCOTLAND.

THE PRESIDENT'S ADDRESS.

Gentlemen,—As is usual at the opening of the session, I shall very briefly address to you a few remarks; and, in the first place, I would simply refer to the many important and valuable papers that were read last session, and the discussions which followed thereon. The whole treated upon subjects of the most useful and practical description, and much important information was elicited by them, the volume forming one of the most complete we have yet had since the commencement of the Institution. Some of the subjects were in continuation of papers read during the previous session, to which I made reference when I formerly addressed you. As, however, the papers are to be specially considered by the members of the Institution, with the view of giving an expression of opinion on their merits, I will refrain from entering into detail upon them. I may here remark that I regret that our civil engineers should contribute so few papers to the Institution. The immense variety of constructions which are constantly going forward connected with railways, harbours, and canals, at home and abroad, furnish an ample supply of subjects for description and illustration; and I trust that in this and in future sessions, these, and the various points connected with the efficient and economical working and maintenance of such undertakings, may be brought forward more frequently and more prominently than they hitherto have been.

I purpose on the present occasion to give a short outline of, and make reference to some engineering works that have come under my observation since last I had the pleasure of addressing you, and put you in possession of some details connected therewith, which were kindly furnished me by the engineer in charge of the works. The first of these I shall notice is the Charing Cross Bridge, now in course of construction. It is intended to carry the South Eastern Railway across the Thames to their West-end terminus at Hungerford Market, and is to occupy the site of the present suspension bridge, which no doubt most of you have seen and admired as one of the late Mr. Brunel's early works.

The Thames at this particular place is about 1340ft. wide and was crossed by Mr. Brunel in three spans, the centre opening being 646ft. This foot bridge is now being removed and a more substantial structure substituted to meet the requirements of the railway.

Mr. Hawkshaw, the engineer of the new bridge, divides the openings (on the Surrey side) of Brunel's bridge into spans of 154ft. each, by means of cylinders placed in pairs at three intervals; the two masonry piers of the suspension bridge, each 34ft. wide, being allowed to remain to form a portion of the new structure. Future generations may be somewhat per-

plexed to acconnt for these "breaks," and naturally say, why were not cylinders nsed there also? This simple reflection, however, would not have jnstified the expense of their removal; and, at all events, knowing the circnmstances, we may safely exonerate the engineer from what might otherwise have appeared to be a piece of engineering eccentricity.

The principle of construction of the main girders of this bridge, though not absolutely new, has never, that I am aware of, been applied on such a large scale. I believe the same engineer is constructing one very similar at Londonderry, combining a carriage way on the top, which will shortly be opened for traffic.

I am aware it is not usual in an address of this kind to enter minutely into the details of any engineering work, however important; my duty being simply in a general way to notice such things, and express a hope that papers on similar works might come before the Institution in the usual and more convenient way. However, as we cannot always get English engineers to give us papers on their works when we wish it, I am tempted in this case to depart from the usual rule, and beg the attention of the meeting to a general description of this work.

The pair of cylinders forming the intermediate pier are distant from each other 49ft. and are somewhat bottle-shaped in appearance. The portion of each sunk below the bed of the river is 14ft. in diameter, cast in seven segments in lengths of 9ft., the flanges meeting and bolted together inside. The portion from the shoulder to the bottom of the main girder is 10ft. in diameter, cast in seven segments in 9ft. lengths, the flanges being also bolted inside, the thickuess of the metal throughout being about 1¼in. In most cases these cylinders have been sunk 40ft. into the bed of the river, to prevent the possibility of any lateral motion, or of their bottoms being disturbed by any subsequent deepening of the river.

When completed, the lower portion up to the shoulder is filled with concrete, made with cement. Brickwork, set in Lias lime, is then used, the whole being snrmounted by two semicircular blocks of granite 2ft. 6in. thick, cut to fit the cylinders, and when bedded projecting an inch or two above it, so as to keep the bottom of the malleable iron girder from restiug on the casting. Both cylinders are joined together at the top by a cross girder, so as to guard against the barest possibility of any swinging taking place. Each cylinder is tested to the extent of 450 tons.

As already stated, these cylinders are 49ft. apart, and as the main girders rest directly upon them, it follows that that width represents the distance from centre to centre of each girder, and affords space for four lines of way. These main girders each weigh 190 tons, and wheu tested to 400 tons, showed a deflection of 1¼in.

The ends of the girders resting on the cylinders are composed of plates formed into rigid rectangular columns the same height as the girder, viz., 14ft., 5ft. ou the face and 3ft. broad. The boxes or troughs forming the top and bottom of the girder are of that breadth, and of course spring from those ends. The upper oue being inverted, its bottom forms the top of the girder, and, unlike the bottom of the lower trough, projects beyond the sides some 6in., and being in compression requires more metal in it; in the middle it consists of six plates—five of them ⅝in. thick, and one $\frac{11}{16}$in. thick, breaking joint, and gradually diminishing towards the ends to two—one $\frac{11}{16}$in., the other ⅝in. thick. The bottom of the lower trough is flush with the sides, and has five ⅝in. plates in the centre and two ⅝in. plates at the ends. The staging was made to admit of the simultaneous construction of these troughs; they are, with the above exception, precisely the same, each being 2ft. deep inside and 3ft. broad; each side is composed of two plates, ⅝in. thick, with two covering plates at pin holes, each 1in. thick; these pin holes occur at intervals of 11ft., and number fifteen in each span; four of the diagonals meet inside the troughs at those places; and two webs of the same thickness as the sides fastened to the bottom by angle irons 6 × 6 × 1, give additional bearing to the pins, and prevent the diagonals from sliding on them. The diameters of the pins vary with the strain, from 9in. at the ends to 5½in. in the middle of the girder.

The diagonals at the ends are about 14ft. 6in. by 12in., and 3in. thick; in the middle, the breadth and thickness are about 6in. and 2in. respectively. Those in compression are forged to the required thickness, and strongly stiffened; those in tension are made up of two or three pieces of 1in. in thickness, according to strain, like the links of a suspension bridge. The cross lattice girders carrying the four lines of way, and projecting beyond the main girders, support a footway 7ft. wide on either side, and are suspended to the main girders by four strong angle irons immediately under each pin, and consequently occurring at 11ft. intervals. There is nothing very special in their construction to require further notice. The weight of each, I understand, is about 9 tons.

The bridge, when completed, will consist of six spans of 154ft. each, and three in the Middlesex side of 100ft. each; and the bridge is to be widened on that side to 171ft., so as to admit of seven lines of rails and platforms into the station. The radiating outside girders over these three openings remain the same in appearance as those of the rest of the bridge, to afford a continuous sky line; they have, however, very little work to do, and are consequently much more slender in construction; they rest on cylinders 8ft. in diameter. The railway is no longer carried on cross girders, lougitudinal ones placed on cylinders 6ft. diameter, sunk at short intervals between the 8ft. outside ones being substituted. These girders are single web, and strongly made, their depth being limited to 5ft. for 100ft. span, to afford 25ft. headway above Trinity high-water mark, and are all under the level of the planking, so as not to interfere with the points and crossings of the lines of way to the platforms. The depth of the Thames at the site of the bridge, at low-water of spring tide is 11ft.

Rise of tide	17ft. 6in.
Level of rails above Trinity high-water	31ft. 0in.

The work is now more than three parts finished, and is perhaps the finest piece of work of the kind in the world. It is difficult to ascertain the cost of such a work. I believe, however, that £26 a ton for the wrought, and £16 10*s*. a ton for the cast iron, will not be far from the mark; 30*s*. a foot might also be taken as a pretty uear approximation for sinking the cylinders.

I shall now proceed to lay before you some particulars of the Middle Level deluge—which caused so much excitement in the early part of this year—and the means resorted to by the engineers to stop it. Unless one has travelled in those districts in England known as the Fens, aud forming large patches in the counties of Lincoln, Norfolk, Cambridge, aud Huntingdon, he can scarcely realise the fact that thousands of families live and move, and quietly follow their farming operations, on a level only some two or three feet above low water mark. Every ploughman becomes an engineer deeply skilled in wattling, puddling, and embanking; and farmers show wonderful skill in the arrangement of their drains, which cut up and interlace their farms, until the water reaches the main drain at a convenient place, to be there pumped up and pounded, until the ebbing tide in the river, often many miles distant, allows it to pass to the sea. The early Dutch engineers, brought over by James I. of England, divided those immense tracts into levels or confederations, each getting peculiar privileges granted them by parliament, with power to levy rates on the acreage benefitted by their main drains and outfalls, for their construction and maintenance.

The Middle Level is one of those, consisting of 140,000 acres, extending nearly to Peterborough, and cut from off the sea-board by a belt of intermediate fens eight miles wide, under separate commissions, each maintaining, by their own taxation, independent drains and outfalls. The only thing common to all is the river Ouse, into which they all in that quarter drain, each commission subscribing to a general purse for the maintenance of its banks. This river rises in Bedfordshire, pursues a north-easterly and very tortuous course, receiving contributions from the Cam and other rivers as it passes through Cambridgeshire, and reaches the sea through the Norfolk estuary, a few miles below Lynn.

It is tidal for many miles into the interior, which during floods hinders the free passage of the water to the sea, and often prevents the gates of the inland main drains being opened for several days together.

The original outfall of the Middle Level waters into this river was, on account of the intermediate fens already mentioned, placed some fifteen miles from the sea, and was particularly subject to irregularity of action. The commissioners consulted the late Mr. James Walker, an engineer who was eminent for his skill in hydraulic works. (Since the preparation of the present remarks the rather sudden death of Mr. James Walker has been announced. This event must be deeply regretted by the entire profession on account of Mr. Walker's very high standing as a civil engineer; but it must be the more felt amongst us on account of his long connection with this locality, and from his being an honorary member of this Institution.) Mr. Walker advised the entire removal of the outfall sluice nine miles further down the river, and that parliamentary powers should be sought to make a main drain across the intermediate fens to it. This accordingly done, and, after encountering a severe parliamentary contest, the act was obtained.

The sluice consisted of three 20ft. openings, the sills being 6ft. below low water of spring tide; strong pointed gates opening outwards prevented the ingress of the tide so soon as the level of the water in the river exceeded that in the drain. The drain, which is perfectly straight, is on an average 130ft. wide; and its bottom, for the eight miles across this district, is 7ft. below low water. The level of the adjoining lands being only 3ft. 6in. above low-water for a length of six miles out of the eight, really gave good grounds for objecting to such a dangerous element being carried out on such a large scale through their very midst. But what they most dreaded was an accumulation of upland or fresh water in the drain during floods, more than could be discharged in the interval of low water, the pressure of which on banks, however carefully constructed originally, might, by negligence in maintenance, become unfit to meet all exigencies. On that ground they opposed the bill, and obtained protective clauses; but it does not seem to have occurred to them that any failure could ever take place in the outfall sluice, and it will be for the courts of law to decide whether those clauses do not altogether exclude the sufferers from any compensation whatever for the damage done by the sea. This is mentioned for

two reasons—first, to point out that the land inundated was not the Middle Level at all, but the intermediate districts; and secondly, to be excused from giving, directly or otherwise, any opinion as to the sufficiency or insufficiency of the works which for eighteen years stood well, and almost convinced the most timid opponents that their former fears were groundless. Everybody admitted the drain and outfall sluices, from their magnitude and apparent efficiency, taken as a whole, to be a masterly piece of engineering.

To the Middle Level the boon was incalculable, and far more than realised the most sanguine expectations of its immense population. Pumping engines in many districts were abandoned, and land which was worthless during the old state of drainage soon brought upwards of £50 an acre.

On the 4th May, this year, Mr. Walker's grand sluice, without much previous sympton of decay, fell in pieces, as if rent by an earthquake; and the tidal waters of the Ouse rushed with indescribable fury up to the drain, until at the end of the eight miles they were checked by the barrier sluice on the frontier of the Middle Level district. The drain for this distance became a sort of creek; and had its bank been strong enough to have resisted until a dam could have been made across the mouth, no inundation to the adjoining country would have taken place. This state of things lasted for a week, several minor breaches in the banks being successfully stopped at every tide, until at last the west bank gave way at a point situate four miles up, and a tide 14ft. higher than the land rushed over the devoted country, then beaming with most luxuriant crops. The land being all of the same level, was not for a few tides covered to any depth, consequently the farmers were able to escape with their lives and also to secure their cattle. All attempts to stop the breach were perfectly futile, owing to the rush of water back to the drain again during low water. This altered state of things had also a wonderful effect on the dam the farmers were trying to put across the mouth. The twenty-four barges, varying in size from 30 to 80 tons each, which had been loaded and sunk in the yawning chasm to form a basin for some thousand sacks of clay to be built on at low water, were speedily separated and turned over; and nothing that could be sunk or thrown into the torrent would for a moment remain.

By the late Mr. Walker's recommendation, Mr. Hawkshaw visited the scene of disaster to see what could be done; and he at once gave orders to give up all attempts to stop the breach in the bank of the drain, which by this time was about 100 yards wide, because, if successful, the chances were that the opposite bank would give way, and do still greater damage to the lands on the other side. He also abandoned the idea of constructing the dam at the mouth, most of which had now been carried to sea, as, in addition to the sacks of clay and other make-shift material which were being thrown in, he wished to drive a few piles; so, taking advantage of a timber bridge of three openings across the drain near the mouth, he had all the pile engines that could be found in the neighbourhood placed on it, and set to work; nothing was to be put in until the piles were driven on either side of the bridge, and strongly braced together; the planking was then to be taken up, and the prepared material dashed in. Matters were so arranged that much progress was made in the course of two days with the driving of the piles; but during the progress of this work, up turns one of the huge 80-ton barges (which was supposed to have followed its companions out to sea), and dashing against the row of newly-driven piles, snapped them right through, and carried away the entire bridge as well as the piling engines and necessary appliances—the men only escaping with their lives. Two other occupation bridges shared a similar fate, but a bridge carrying a turnpike road resisted sufficiently to afford time to secure it. This was a most unfortunate accident, as great difficulty was experienced in getting a supply of pile engines in the neighbourhood.

Now was the time for the Dutch engineer, who, with Mr. Hawkshaw's consent, had been set down to try what could be done by sinking cradles, for such was the excitement generally throughout the country, and the imminent peril of the surrounding district, that Mr. Hawkshaw, seeing the time which must necessarily elapse before the destroyed land could be replaced, and a dam, such as he deemed necessary could be constructed, felt he would not be justified in offering any opposition; but, on the contrary, he heartily supported him. In the meantime, a few tidal and other observations established some facts that set all minds at ease, and went a great way in discountenancing the Dutch mode of procedure. First, the land inundated extended six miles along the west side of the drain, and was two miles broad at the widest place. On an average the water was 5 feet deep over all, being luckily confined to that area and depth by the existence of two roads which stood about 1ft. 6in. above that level, and surrounded it for many miles; and second, the tidal observations showed that the tide affected the level of the vast lake to an extent of only 6in.; so long, therefore, as the level of the roads held good, no further damage could arise by the free admission of the tide. The Dutchman, failing in the first attempt, was preparing a second cradle, when it became a very serious question whether he would not, by pounding up a certain quantity of water every successive layer of cradles he sunk (for to stop it in a few tides was not to be hoped for) gradually, but undoubtedly, raise the level of the water from 9ft., at which it stood until, in the course of time, it would approach the height of 18ft., which was the mark the same tide made at the dam. Where then would be the 1ft. 6in. we had to come and go on? His operation was, therefore, after due deliberation, stopped.

The difference of level of the water in the fen from that in the Ouse arose from the tidal current having to pass four miles through the drain before entering the inundated land; and from the extent of area inundated being no less than twelve square miles, it only affected the height of the water in the fen to the extent of 6in., as afterwards explained.

Before giving a description of Mr. Hawkshaw's dam, I may state some of the difficulties he had to contend with—Firstly, The high water in the inundated fen, as compared to the same water in the Ouse, was as 9ft. to 18ft., and the tide rose and fell in the fen 6in. Nothing approaching low water in the river could ever therefore be obtained in the drain. The only interval of repose, or what might be called slack water, was when the tide outside attained the height of 8ft. 6in. or level of the low water in the fen. Ten minutes time was sufficient to send a gentle current inwards, which increased in velocity every minute afterwards until high water; but the high water in the river being 9ft. higher than in the fen, no still water was again obtained until the tide had receeded in the river to that level; it then rushed out like a mill stream until the tide rose to 8ft. 6in. again. Secondly, The bed of the drain being 7ft. below low water mark, it followed that, at the time of slack water, when any work could be done at all, the depth of water in the drain was 15ft. 6in.; this was increased some 2ft. more, notwithstanding all efforts to maintain the bottom. The drain a short distance inside the site of the dam was ultimately deepened to 17ft. for a distance of 20 chains. Great caution was, therefore, necessary in any attempt to contract the sectional area.

The first thing to be done was to construct across the drain a strong stage 30ft. wide, resting on screw timber piling, which was projected into the current—the capstans on the piles being turned by ropes from the shore. Close piling on each side of this staging was then commenced, and continued from each shore until a clear space of 90ft. in the centre remained, it being considered imprudent to carry it further. This space was divided into twelve openings, by driving twin piles on each side of the stage opposite to each other, at 7ft. 6in. intervals. Great care was necessary in pitching those piles, and it could only be done during the short time of slack water. Each pile was 14in. square, and separated from its fellow by the first one having a thin piece fixed to its outer face, against which the second was driven, thus forming two grooves, 8½in. wide, for the panels, which were intended to be dropped into the openings, to slide in. Strong waling pieces of whole timber inside and out of each row at top, and as low as the water would admit of at the bottom, kept the whole in gauge, and the transverse timbers and iron bracings communicated any outward pressure through the dam from one row to the other, the outside of the dam being staid to the side of the drain by double timbers, 60ft. long, the ends abutting against piles backed by a mass of concrete. These struts were placed against the waling pieces at top and bottom, and stiffened by cross diagonals like a girder. The staging was left open at the top, to admit of material being tipped from the two lines of way, laid across the dam, and communicating with the prepared heaps of puddle and other material at convenient places up and down the drain on both sides. Two outside stages, one on either side of the dam, and supported by cantilevers from the twin piles, admitted of almost any quantity of tipping from barrows, to make good any scour which the soundings taken at every slack might indicate. The rush of water through the dam thus far completed, was, both on the flood and ebb tide truly alarming; the simple introduction of those piles and bottom walings causing a difference of head level of nearly 5 feet. In the midst of this roaring cataract, this framework and the dam stood without the slightest vibration being felt. It was daily visited by thousands who, though reserving to themselves the right of grumbling at what they did not understand, could not but admit it to be the only way of meeting the difficulty.

The greatest and most anxious care was now necessary to preserve the bottom of the drain from the scouring action of such a weight of water passing over it at the rate of 10ft. a second. Tons of broken stone were tipped from the outer stages and thrown overboard from barges, to form aprons on either side. But, except as a last resource, no stone was to be thrown into the centre of the dam, lest it should prevent it afterwards from being made perfectly water-tight. The long panels composed of timber 8in. thick, not framed, but merely built one above the other, and held together by three long bolts and heavy iron straps, made them quite rigid, and no difficulty was experienced in driving them. They were made with a sharp edge, and dollied down until their top was level with the bottom of the drain, or nearly so, and backed well outside with stone. Great quantities of puddle were tipped into the dam at every slack water; not with any hope of its remaining, but simply to feed the cancer—if I

may so express it—and thereby allow less time for the dreadful current to act on the bottom. This was all the more necessary, for the piles on an average could only be driven 14ft. into the ground. All attempts to exceed that depth resulted in fracture. No doubt a bed of gravel existed at that depth, totally different in character from the coarse silt and alluvial deposit resting on it, and now so anxiously maintained.

The first attempt at closing the dam resulted in failure from the fracture of two of the twin or guage piles, which doubtless were injured in the vain attempt to get them deeper into the bottom. No blowing, however, occurred, and the panels when liberated were carried off. The greatest apprehension existed until the return of slack water, when the divers reported no damage, the lower panel, driven into the ground, prevented any cutting of the bottom. In consequence of the failure all the other panels down to low water were drawn, to allow free access to the tide, until the piles could be replaced. This was accordingly done, and a week elapsed in making good the damage and otherwise preparing to meet other contingencies, of which experience was daily pointing out the possibility. All was now ready; the panels were again swung in the gallows frames, ready to be dropped at slack water on the ebb. They were all lowered into their places in twenty minutes, material was then tipped in with great rapidity by the waggons, and the outsides weighted from the barrow stages. All was most successful; a little blowing took place where the stumps of the fractured piles interfered with the proper fitting of the panels in those places. However, by throwing a great quantity of hay, and piling a great quantity of clay bags on each side, it was checked until sufficient puddle was tipped into the centre. This was accomplished in twenty-four hours, and set so completely that not a drop escaped through. The tides no more went up the drain, but ebbed and flowed outside with a stillness which, when compared with the previous day, partook of that oppressive character experienced near a mill, or in the midst of going machinery, suddenly stopped. Syphons 3ft. 6in. in diameter were then placed over the dam to relieve the Middle Level from the surplus water that would not find its way to the Ouse through the old outfall, which for the present was again resorted to. Many thought they would not act. No good reason, however, could be urged against them, and all admitted that it was proper to make the experiment. These syphons have been finished and recently opened, and all found to do their work very well indeed. Their bottom level where they pass over the dam is 18ft. above low water, and the bottom of the mouths 6ft. under low water. In spring tides, high water rises 20ft. These operations have succeeded in relieving the Middle Level of water, and it will be a great boon to the whole of that district.

I trust that, while some of the members may consider the description and details of these important works uninteresting, others will be benefitted by them, and be led thereby to see the necessity of perseverance, so as to overcome unforseen difficulties that may be expected to arise during the progress of such works.

I have already referred to the desirability of more papers on civil engineering being brought before the Institution. It may be that the members who carry out the works which would form the subject of such papers, have not time for their preparation. But the younger members may take up any great work either in progress, or which has been completed, but not yet publicly described; and in doing so they need not limit themselves to works in this country. The rapid extension of railways on the Continent and in India is constantly giving rise to the necessity of constructing works of great magnitude; there are mountain ridges to be cut through, and ravines and rivers to be crossed of much greater magnitude than anything with us. In executing such works, the engineers in charge of them have the benefit of our experience. Few of us have an opportunity of inspecting these works in detail, either when in progress or by going over their plans. But I have no doubt that some of our members have the means of giving a professional account of many of these works, which, if brought before this Institution, would be most instructive and interesting. For instance, there are the Victoria Bridge at Montreal, the various railway bridges over the Rhine at Cologne, Mayence, and Strasburg, as well as others of similar construction across Indian rivers—all works of great difficulty and magnitude, and involving many novelties in construction which would each furnish a valuable subject for a paper. All these works are of wrought-iron, with arches of great span across wide and navigable rivers subject to great variations of level; and both in the general design and construction, they offer important lessons to the engineer. The Victoria bridge is a tubular one, and all the others are lattice bridges. Should the details of such works be brought before us, I would suggest that a careful comparison of the advantages, the difficulties, and the cost of the two systems of construction should be made, which I have little doubt would show that the lattice bridge is by far the better and the cheaper of the two. In these lattice bridges over the Rhine we have examples of the largest description of swing bridges yet constructed; and altogether, for elegance of design, excellence of workmanship, and economy in cost, I believe them to be unrivalled among recent railway structures. Those at Strasburg and Cologne are completed, and the one at Mayence is now in progress. The first consists of three central arches, each 184 ft. span, and of two side swinging arches 85 ft. span. The central piers are finished with handsome and effective Gothic spires, and the general appearance of the whole is most satisfactory. Its total cost was about £280,000. The bridge at Cologne is much larger, and embraces a railway and roadway alongside of each other, the cost being, I believe, somewhere about £500,000.

In carrying out the Swiss system of railways, ample opportunity has been afforded for the exercise of great engineering skill and ingenuity, of which full advantage has been taken. These must strike the eye of the professional tourist, even during the hasty run which is now taken by many among the Alps in summer; and there are two lines now in progress, which, when completed, will present works of a much more striking character than anything now in operation: these are the lines from Geneva to Turin by Mont Cenis, and from Martigny to Milan by the Simplon Pass. The first is now certain to be carried out, and its great and important feature will be the tunnel through Mont Cenis, which will be about eight miles long, and above 6000 ft. beneath the crest of the mountain. Of course, at such a depth intermediate shafts cannot be resorted to, so that the whole excavation must be carried on from either end. This very greatly increases the difficulties of the work; and these difficulties, coupled with the constructive skill necessary to be displayed in overcoming them, are such that the completion of the tunnel will be regarded as an epoch in rock excavation. The cost will be somewhat enormous, and would have been insurmountable, had it not been for the assistance given by the French and Italian governments.

The other line over the Simplon will have a higher summit level than that across Mont Cenis. Many points connected with its construction have not yet been determined, such as the level and length of tunnelling at the summit. When completed, it must embrace many works of striking magnitude and novelty, which will completely eclipse those of Napoleon's famous road, so long the admiration of Europe.

These railways will be of immense value to the countries they connect, more especially to Italy, which has suffered so much and so long from its commercial isolation from the rest of Europe; and I need not point out how valuable it will be to the profession, to have full and exact details of the most novel and striking of these works. In obtaining these, any one of our members can easily have the advantage of personal inspection of the works, should he find this necessary for an accurate description. Not so, however, with respect to those great works in India or America. At the same time many of these are made with English capital and by English engineers; and where this is the case there will be no difficulty in obtaining access to the plans. Some of the iron bridges have, indeed, been made in this country, and these now form the largest and most interesting of recent railway structures; so that the difficulty of obtaining the necessary details is not so great as may at first be supposed.

The railways in our American colonies, though invaluable to the districts through which they pass, have hitherto been unremunerative. This result has, to a large extent, been caused by inattention to economy in construction, and, as many believe, by disgraceful jobbing in financial matters. Notwithstanding these drawbacks, I have no doubt but the rapid progress of these colonies in material prosperity will soon furnish traffic to make the present lines profitable undertakings. By that time the colonies on the western shores will also be far advanced in commercial importance, so that we look forward at no distant date to an extension of the Grand Trunk of Canada across the Rocky Mountains to British Columbia. Such an undertaking will necessitate the construction of works of magnitude equal to, if not greater than those already completed. Its effect on the development of the resources of the vast territory which it will traverse, will be invaluable. The result, therefore, will be equally great in a professional and national point of view, and may claim the attention alike of the engineer and the statesman.

The great question of cotton supply renders the rapid extension of railway transit in India a matter of the most pressing and immediate importance. Invaluable time has already been lost in endless discussion of detail by parties who were entirely unfitted for such work; and it is to be hoped that now, when a beginning has been made, Indian railways will be pressed on with all practicable speed. It has been a matter of bitter reproach against England by Burke, and by all who have followed him in challenging our Indian policy, that we have done so much in conquering the natives and in enriching ourselves, and so little in opening out the material resources of that magnificent country. Our greatest boast has been our advancement in the arts, in mechanics, and engineering, and more especially in all processes connected with improvements of land transit; yet, during the century of our sway in India, we have allowed the great works of artificial navigation made by former engineers to fall into decay, and have been contented to carry on intercourse in one of the richest and most populous countries in the world by bullock tracks, like those described by Livingstone as being used by the African savages among whom he travelled.

We have now entered upon a different policy. Trunk roads and trunk railways have been traced out, and partially constructed between the capitals of the various Indian provinces. We have commenced to improve the river navigation, and to place steamers on all the larger streams. The old tanks and

canals for irrigation have been repaired, improved, and greatly extended; and if this course be persevered in, we may expect to see the whole country opened up in a short time by works which will make internal transit there as cheap and efficient as it is with us, and which will form the most striking monument yet raised to the power and magnificence of Great Britain. I need not point out what a large field of engineering employment the construction of these works will open up, nor the necessity of smoothing away the difficulties which their construction will give rise to, by a full discussion of them at institutions such as this.

I alluded, in my address of last year, to the prospects of the Great International Exhibition, and to the part which we expected the industry of the west of Scotland to occupy, and I am glad to be able to congratulate the members that our expectations in these respects have been fully realised.

The Exhibition, almost in every respect, exceeded that of 1851 as regards number, variety, and importance of the articles brought forward; and Great Britain, on the whole, has had reason to be proud of the position she has occupied in the grand industrial tournament to which she had challenged the world. In the production of metals, chemicals, glass, and earthenware, and of all ordinary woven fabrics, we have undoubtedly distanced all competitors, with some very few exceptions.

In the case of machinery, the department more peculiarly interesting to engineers, it may be said without exaggeration that we have been first. There certainly is no comparison between our locomotives, our marine and land engines, our spinning and weaving machinery, our sugar-mills, and our tool-making machinery and those exhibited by our rivals; and it must have given great satisfaction to all of us to see the honourable position occupied by many of our own members who are exhibitors in these classes.

Amongst the few exceptions I have referred to, I may mention railway carriages and their fittings, cast-steel forgings, and some of the unusual forms of rolled iron. It has long been matter of common remark, that the carriages of foreign railways were better and more comfortable than those of a similar class with us. This may be partly explained by the large proportion of old and badly-constructed stock still kept up by many companies in this country. But even allowing this, I am afraid that it must be admitted that foreign stock of railways is fully superior to our own; and there can be no doubt that the best foreign carriages exhibited were fully equal, if not superior to those of English make. Many reasons have been assigned for this, but they may all be resolved into the simple fact that our foreign rivals have paid more attention than we have done to the proportions and quality of the fittings and to the excellence of the workmanship in every minute particular. It is impossible to over-estimate the importance of attention to these points, not only as regards the comfort of passengers, but also as regards the question of economical working. Repairs and renewal of rolling stock form a very large portion of the working expenses of a railway; and to use stock after it becomes ripe for renewal is not only severe upon itself, but is equally injurious to the permanent way. The rail and the wheel are, in the words of Stephenson, "man and wife," and you cannot injure or depreciate the one, without doing corresponding damage to the other. This great truth is now fully recognized in railway management, and is shown by the increased attention which is being paid to the improvement of rolling stock and of the permanent way; and I hope that such attention, coupled with the natural decay of old and objectionable rolling stock and its renewal, will soon enable us to surpass all continental railways in these all-important matters.

It must have struck every one that foreign carriage fittings in iron, more especially those from France, were also fully equal to ours. They were certainly lighter and very well made; and I was surprised at being informed that they were actually cheaper than with us, being only on an average 2½*d.* per lb. This is a somewhat astonishing result, if we consider that the raw material is 25 to 40 per cent. dearer in France than in Britain. We have almost all the materials for iron-making—the ore, the coal, and the lime, lying in close juxtaposition, so that with us the cost of raw material is very small indeed. But in France they are widely separated, and the extra cost of carriage, compared to what it is with us, raises the price of pig-iron from 60*s.* to 90*s.*, and of bar-iron from 130*s.* to 170*s.* per ton. It is very much to the credit of the French manufacturers that they can, in the face of this great difference against them, produce iron work of first-class quality as cheaply as in Britain.

They also produce angle iron, T-iron, and I-iron of extra sizes for smaller extra charges than those made by our makers; and they have carried the manufacture of these extra sizes and forms much farther than we have done; and I understand it is the case that many of these sizes and forms must be ordered by our Glasgow iron merchants from French and Belgian makers, and the prices are so low that I-beams, 12in. deep, cost only £12 10*s.*, and when 2ft. deep, £20 per ton. There is no doubt that the advantages we possess for ordinary sizes and qualities, with proper skill and attention, ought to be carried into every branch of the manufacture. Were this done our foreign trade would be greatly extended, and the use of iron would be adopted to a larger extent in many kinds of industry.

A good deal of the uncertainty attendant on the introduction of iron-making arises from the obscurity which still surrounds many of the chemical changes that take place in its various stages. This obscurity can only be removed by accurate experiments on a large scale. These could easily be conducted by many of our members who are connected with the manufacture; and such a series of experiments, besides being of great value to the makers, would furnish the subject of many excellent papers, which I hope to see brought before the Institution.

In concluding these remarks, I have much pleasure in being able to congratulate the members on the increased and increasing prosperity of the Institution in every respect. Although, we however, had a considerable increase in the number of members last Session, we must not show any laxity in increasing the number with suitable members still more, so as to keep up our funds, which naturally will fall off, owing to the entry-money and yearly subscriptions having been recently reduced; and this is the more necessary as we will require to draw pretty heavily on these funds in the establishment of such a library as will be worthy of the Institution.

I refer with much satisfaction to the pleasant and agreeable meeting our last conversazione afforded the members and their friends; and much praise is due to our Secretary and the members of committee who were intrusted with the arrangements. I trusted that the Institution may see proper to have a similar meeting at the close of the present Session, as I think such meetings have a tendency to create good feeling and harmony amongst the members of the Institution.

On the motion of Mr. R. Bruce Bell, a hearty vote of thanks was awarded to the President for his very interesting address.

Mr. Walter Macfarlane begged permission to offer a few remarks, suggested by the President's address. The member must feel deeply indebted to the President for bringing so fully before them the railway bridge and terminus at Hungerford, which was to connect the railways on both sides of the Thames at Charing Cross. There was a probability of their soon seeing a scheme launched in Glasgow of a kindred sort—a general terminus in this city to connect all their railways. He could not but express his regret at the very disgraceful state in which Glasgow stood in regard to her railway termini; and it must be patent to them all that a large amount of money was unnecessarily spent from this cause. It had generally been held that the great obstacle to the success of a general terminus was its expense, which he did not think should be the case in such a city. Seeing that London, with the view of centralizing her various railway depots, had carried out such a scheme, he thought there would be no difficulty in this, the second city in the empire, following the example, and taking a position more creditable than it now occupied. The President's remarks were most suggestive, and a meeting such as the present was most valuable, as it gave a good opportunity for bringing their engineering opinions to bear upon a scheme before it was finally committed. Glasgow should look upon this matter in a broad aspect of view, and see the necessity for having railway accommodation commensurate with the increase and extent of the city. The Central Railway Terminus to which he had referred was very much akin to the Hungerford Market and Bridge scheme. Hungerford Market had only been established thirty years, and yet it was being removed at enormous expense; and if one or two railways at London could do this, he should be disappointed if Glasgow were not soon in a similar position.

The President endorsed all that Mr. Macfarlane had said. He was of opinion that if it was found necessary to join the London railways, much more was that the case in Glasgow, for it would connect the leading lines in the west and south of Scotland with those of the north and east of Scotland. He knew a good deal about the scheme referred to, having been consulted in reference to it. He had seen Mr. Hemans, the engineer, who had got ready the plans and a very fine model, which was exhibited in one of the booths at the west-end of Bothwell-street. He believed the chief difficulty was the want of money, but partly also the absence of co-operation on the part of the railway companies. However, he had no doubt that the scheme would come up soon, although it would not be proceeded with in the present session of parliament.

ON THE UTILIZATION OF PEAT, WITH REFERENCE MORE PARTICULARLY TO THE MANUFACTURE OF HYDRO-CARBON OILS.

By B. H. Paul, Ph.D.

(*Continued from page* 17.)

The amount of tar obtainable from the peat is of considerable importance. The amount obtained by Mr. Sullivan from Irish peat, in no instance amounting to 5 per cent., and on the average 2·5 per cent., is far to small to admit of the peat being worked profitably.

The influenced of an increased yield of tar on the cost of the products, will be very clearly apparent from Table II., in which the quantity of peat worked per week is throughout taken as 100 tons, and the yield of tar varying from 1 to 10 per cent.

It will be seen that a yield of 3 per cent. tar from the peat would, at the cost of peat and labour assumed in this table, make the cost of the tar £6 6*s.* 8*d.* per ton, and that if the refined product from the ton of tar amounted to only 100 gallons, the cost of the oil would be 1*s.* 10*d.* per gallon, or far too much to admit of profitable working.

To determine this point, therefore, with certainty, an experimental distillation of the Lews peat—air dried—was made in a close retort, it gave the following results :—

Tar			9·855
Charcoal	Carbon	30·25	31·500
	Ash	1·25	
Water			37·875
Gas			21·549
			100·000

which were subsequently confirmed by trials on a larger scale.

TABLE II

Per centage yield of tar from peat.	Quantity of peat worked per week.	Tar produced.		Refined oil and paraffin.	Cost of Tar made.			Cost of tar per ton.	Cost of tar equivalent to 1 gallon refined products; these being 100 gallons = 1 ton tar.	Cost of refining per gal.	Cost of refined oil per gallon.
		Tons.	Gallons.		Peat 2*s*. per ton.	Labour.	Equal				
				gals.	£	£	£	£ *s*. *d*.	*s*. *d*.	*d*.	s. *d*.
1	100	1	233	107	10	10	20	20 0 0	4 0	6	4 6
2	100	2	460	214	10	10	20	10 0 0	2 0	6	2 6
3	100	3	699	321	10	10	20	6 6 8	1 4	6	1 10
4	100	4	932	428	10	10	20	5 0 0	1 0	6	1 6
5	100	5	1165	535	10	10	20	4 0 0	0 10	6	1 4
6	100	6	1398	642	10	10	20	3 6 8	0 8	6	1 2
7	100	7	1631	749	10	10	20	2 17 2	0 7	6	1 1
8	100	8	1864	856	10	10	20	2 10 0	0 6	6	1 0
9	100	9	2097	963	10	10	20	2 4 6	0 5½	6	0 11½
10	100	10	2336	1070	10	10	20	2 0 0	0 5	6	0 11

The tar thus obtained, as I have already mentioned, yielded 42 per cent. by weight of refined oil and paraffin; so that the 100 tons of peat, as compared with the average of Irish peat, would yield:—

	Tons.		Tar. galls.		Crude Oil. galls.		Refined Oil. galls.		Creosote. galls.
Lews peat	100	...	2,097	=	1,629	=	999	+	630
Irish peat	100	...	479	=	686	=	357	+	343

In this case, taking the cost of the peat as before at 2*s*. per ton, the quantity of Lews peat, equivalent to one gallon of refined products, would cost only 2½*d*. instead of 7*d*., as in the case of the Irish peat; and adding in each case 1*s*. per gallon as the cost of manufacture, the refined oil from Lews peat would cost 1*s*. 2½*d*. per gallon, while that from Irish peat would cost 1*s*. 7*d*. per gallon.

In the above table the cost of manufacture is taken from the results of actual experience; but the per centage of tar, which I have just referred to as obtainable from the Lews peat, was obtained by distilling it in a close retort. This is not the plan that has been adopted practically, and it is possible that in distilling peat with close retorts, the cost of manufacture would be increased beyond what has been quoted in the above table, by the necessity of using peat for fuel; if, for instance, it should be found that the charcoal obtained from one operation was insufficient for the distillation of a subsequent charge of peat. If that were the case, the working with close retorts would involve an additional expense for fuel. The peat thus consumed as fuel would, in reality reduce the actual per centage of tar obtained from the peat consumed, and if one-third the weight of the peat were consumed as fuel, the per centage of tar obtained would be, in fact, not 9·8 per cent., but only something like 6 per cent.

At the outset of the inquiry into the working of the Lews peat, it therefore became an important question whether it would not be more economical to work with kilns, as was done at the Irish Works; whether the large yield of tar obtained with retorts was not to some extent only apparent; and whether a smaller yield of tar. obtained by means of kilns, might be more advantageous by reason of their smaller original cost, and of their requiring a smaller expense for labour and fuel in working than retorts.

The small amount of tar obtained from the peat at at the Irish works was, no doubt, partly a consequence of the inferior character of the peat; but a little consideration of the circumstances under which the peat was distilled will suffice to show that it was mainly attributable to the use of the blast employed in maintaining the combustion, in the same manner that it is employed in an iron-smelting furnace. Some results are indeed mentioned by Mr. Reece, and quoted by Sir Robert Kane in his report, which clearly suggest this view. Thus. for instance, Mr. Reece states that, in the experiments made in Antrim, in 1850, with a kiln 3ft. diameter and 15ft. deep:—

When the quantity of peat distilled during 24 hours was 1½ ton, the produce of tar was 70lbs. per ton = 3·1 per cent.

When the quantity of peat distilled during 24 hours was 2 tons, the produce of tar was 40lbs. per ton = 1·8 per cent.

When the quantity of peat distilled during 24 hours was 3 tons, the produce of tar was 22lbs. per ton = 0·91 per cent.

When the quantity of peat distilled during 24 hours was 9 tons, the produce of tar was only 2lbs. per ton.

In the experiment by Dr. Hodges, which gave 4·44 per cent. of tar, the distillation of two tons of peat occupied three days, and the blowing machine employed in that experiment is described as having been "very inefficient," and furnishing only "an intermittent blast of no great power." The same fact is pointed out in Sir Robert Kane's report, as having been observed in the course of the investigation made at the Museum of Irish Industry by Mr. Sullivan. When much air was blow through through the apparatus, scarcely any condensible products were obtained; when little air was blown through, the distillation was very slow and incomplete.

This result of a very small yield of tar when a strong blast was used appears to be clearly attributable to the peat having been burnt in the kiln instead of having been distilled; and this view of the matter led me to the conclusion that it would be advantageous to dispense with the blast altogether, as being not only very expensive, but also useless and unsuitable for the production of tar. It appeared to me that a more appropriate means of maintaining the combustion of the charcoal at the lower part of the kiln, so as to produce the requisite heat for distilling the peat at the upper part, would be to have a fire-grate at the bottom of the kiln, and to establish a draught through the fire by exhaustion from the upper end of the kiln. It appeared to me, moreover, that by this means the escape of the tar vapour from the kilns would be facilitated in a much greater degree than by the blast driven into the kilns at the bottom.

This opinion was supported by the result of some experiments made with a small kiln, constructed in this manner, which was worked for some time in Lews. In this kiln the draught was produced by means of a chimney placed at the further end of the condenser, and the yield of tar obtained with this experimental kiln amounted to 5 per cent.

The tar thus produced differed somewhat from that obtained by distillation in close retorts chiefly in respect to the relative proportions of light and heavy oils and paraffin, as will be seen by the following results of the analyses of these two tars:—

	Density.	Retort Tar.		Kiln Tar.
Light oil	(0·820—0·830)	18·678	..	5·147
Heavy oil	0·870	20·165	...	30·885
Paraffin		3·318	...	5·135
Creosote		30·459	...	47·068
Charcoal gas and waste		27·380	...	11·765
		100·000	...	100·000

This difference might, however, be owing to defective condensation of the more volatile portions of the tar vapour, as the arrangements connected with the experimental kiln were in many respects very imperfect. Otherwise the tar was as easily worked as that obtained with close retorts and the general result of the trials made with this kiln was so far favourable to this mode of working, that when arrangements were made for erecting works to make six tons of tar a week, it was determined to construct a range of kilns of this description, in preference to putting up retorts; at the same time it was hoped that with a more efficient arrangement for condensing the tar vapour, a larger yield of tar than 5 per cent. might be obtained.

These preliminary matters having been satisfactorily disposed of, preparations for erecting works were commenced in the early part of 1859. The tar kilns were cylindrical baick chambers 5ft. diameter and 12ft. high, with a fire-grate of about 2ft. area at the lower end, and a hopper with a lid at the top for introducing the peat. Ten of these kilns were constructed side by side in a block of brickwork. From the side of each kiln passed a pipe 12in. diameter, which was connected with a main 3ft. diameter, extending round the whole range of kilns, and into which the tar vapour from the kilns was discharged. From this main the vapour passed into a series of pipes 12in. diameter, arranged on cisterns much in the same manner as the condensers of gasworks, but with the difference that there was no water joint. After passing through this condenser the uncondensed gases were discharged into a brick chamber with numerous partition walls, and thence into a large flue running for about fifty yards up the side of a hill on the top of which was placed a chimney 30ft. high.

A tramroad ran along the top of the kilns, communicating with the tramroads diverging through the moor, for bringing up the supplies of peat: and, as the peat burnt away at the fire-grates, a fresh quantity was introduced at the upper ends of the kilns. This charging required to be repeated every two or three hours. The product collecting in the condenser cisterns was a thick creamy mixture of tar and water of a pale sulphur colour. from which the tar was separated by heating it in a large boiler and skimming the tar off the surface.

With this arrangement work was commenced about the end of August, 1860; but, owing to the wet state of the brickwork, and to a temporary difficulty with the workpeople, it was not until the early part of October that the kilns were got into regular working order. From that time the work was carried on without any considerable interruption until the end of February, 1861. The results obtained during this period were far from being satisfactory. In the first place, the tar made did not amount to more than 3 per cent. of the peat consumed; and, in the second place, the quantity of peat worked did not amount to more than 50 tons a week on the average.

The expenses of labour in working the kilns being very nearly the same, whether the quantity of peat worked was large or small, the slow rate of working necessarily increased the cost of the products. and this circumstance has an influence as important in this respect as the yield of tar, as will be apparent from the comparison given in the annexed table.

Moreover, the rate of working was subject to wide variation. This latter circumstance, which was productive of much inconvenience, appeared to be mainly determined by the state of the wind. During calm weather the quantity of peat worked was not much more than half that worked when there was a fresh breeze. With a dead calm the action of the kilns would sometimes be entirely stopped, and during gales, which were of very frequent occurrence, it was impossible to continue working. The most troublesome effect of these two extreme conditions was the production of a back draught from the chimney, though the condenser, towards the kilns, by means of which air became mixed with the

Per centage yield of tar from peat.	Quantity of peat worked per week.	Tar produced.		Refined oils and Paraffin.	Peat 2s. per ton. Labour.	Cost of Tar per ton.	Cost of Tar equivalent to 1 gallon of Refined Oil.	Cost of Refining per gallon.	Cost of Refining Oil per gallon.
	Tons.	Tons.	Gallons.	Gallons.	£ £ £	£ s. d.	£ s. d.	£ s. d.	£ s. d.
5	50	2½	583	268	5 + 10 = 15	6 0 0	0 1 2½	0 0 6	0 1 8½
5	120	6	1398	642	12 + 10 = 22	3 13 6	0 0 9	0 0 6	1 3 0
5	200	10	2330	1070	20 + 10 = 30	3 0 0	0 0 7¼	0 0 6	0 1 1¼

vapours and combustible gases; and, when this admixture reached a certain limit, explosions sometimes took place, which were both inconvenient and dangerous.

The slow rate of working which, as shown by the following table, rendered the charge for labour proportionately much greater, was, to a great extent, a consequence of the feeble and irregular draught produced by the chimney. In addition to this, the tar vapour did not appear to escape from the kilns through the 12in. discharge pipes with sufficient ease. The consequence was that much tar was condensed among the cold peat at the top of the kiln, and this tar, melting afterwards, ran down to the fire, and was there more or less burnt and destroyed. Hence the small yield of tar.

Since the feeble draught of the chimney was the chief cause of these unsatisfactory results, and since that was itself a consequence of the extreme refrigeration of the vapour and gas during its passage through the condenser, the defective draught might have been remedied by maintaing a fire at the base of the chimney, so as to heat the cold uncondensed gas escaping from the condenser, where the tar had been deposited, sufficiently to produce a steady draught; but, since the gas escaping into the chimney was highly combustible, this would have been too hazardous a plan to adopt, inasmuch as the weather was frequently so boisterous that it was with difficulty that work could be carried on at all out of doors; and, as the kilns were worked continuously, there would heve been much inconvenience attending this mode of workiug duriug the very long nights of winter.

Under these circumstances, it appeared to me desirable te have recourse to some mechanical means of producing a draught, that would be constant in its action, easily under control, and which would admit of the gases discharged from the condenser being burnt with safety by the introduction of a water joint between the condenser and the place where they were burnt. A further reason for adopting an arrangement of this kind was the presence, in the uncondensible gases escaping from the condenser, of a large quantity of tar, which was suspended in a kind of vesicular position, and was not separable by any amount of cooliug that was practically applicable. The smell produced by the escape of this tarry gas into the air was exceedingly offeusive for miles around, and for this reason, as well as for the sake of using the gas as fuel, it was determined to burn it. Moreover, though the separation of this suspended tar could not be effected by cooling the gas, it was easily separated by mechanical means, such as passiug the gas over loose bunches of heather. This plan has been adopted while working with the chimney draught, and, so far as the separation of the tar was concerned, it succeeded perfectly. A long brick chamber was connected with the flue leading to the chimney, so that the gases were made to pass along it in a zigzag course by coming in contact with bunches of heather tied to cords and suspended from the roof of the chamber. The effect of this arrangement in separating the suspended tar was instantly recognisable, the gases escaping from the chimney being almost free from tar. But the draught of the chimney gradually decreased, and at the end of two or three weeks had ceased altogether. On opening the chamber it was found to be entirely choked with tar that had been deposited upon the bunches of heather like drifts of snow. This circumstance suggested the introduction of several such chambers into the condenser, and it was also expected that the passage of the vapour and uncondensible gas through water would have a similar influence in separating this tar. But to overcome the resistance that would thus be offered to the passage of the vapour and gas from the kilns, it was necessary to have a very powerful draught, and, after cousidering the various means employed at gasworks for exhausting, I decided upon trying the effect of a revolving fan. A very excellent form of fan of great power was suggested for this purpose by Dr. Rankine, but, as time was a considerable object, one of the ready-made fans, manufactured under Schiele's patent, by the North Moor Foundry Company, was chosen for the trial.

In order to get a satisfactory result in working the kilns it was necessary to work up at least seventy tons of peat a week, and to obtain fully 5 per cent. of tar. Assuming that by the application of a fan this result was obtained, then the quantity of uncondensible gas passing away from the kilns might be taken as consisting essentially of the carbonic oxide produced by the combustion of the coke or charcoal yielded by that quantity of peat, plus the oxygen of the air required for its combustion. Taking the peat to yield 25 per cent. of charcoal, and the quantity worked as ten tons daily, there would be some 4lb. of carbon to be converted into carbonic oxide per minute in the kilns. This quantity would require rather more than 300 cubic feet of air, which, by conversion into carbonic oxide, would become about 360 cubic feet, and, at the temperature it entered the fan, might amouut to 500 cubic feet. This, then, fixed the minimum capability of the fau to passing 500 cubic feet of gas per minute, even if the quantity of peat worked did not exceed seventy tons a week. But this rate of working was considered too small, and I was desirous of increasing it to double or three times as much, and with that object decided upon employing a fan capable of passing 2000 cubic feet of gas per minute, so as to leave an ample margin for increasing the rate of working, and to allow for any augmentation of the voluume of gas not calculated for.

The fan chosen for this purpose was a 30in. Schiele's fan, driven at a rate of 1600 revolutions by an 8in. engine, which worked some pumps and a winding drum, by which the peat trucks were drawn up an incline to the kilns. This fan was found to produce a powerful steady draught through 7in. of water, without raising the combustion at the fire-grate of the kilns to a higher degree than was desirable. The area of the discharge pipes from the kilns having been doubled, the vapour was rapidly drawn from the kilus, and the tar was much more completely separated by passing the vapour several times through water and through four chambers filled with layers of heather. The mechanical action of the fan was also found to be very efficacious in separating the suspended tar, which appeared to be churned out of the gas by the fan.

The current of gas discharged from the fan was highly combustible, and burnt freely at the ordinary temperature. In order to prevent its causing an unpleasant smell, and to render it available as a source of heat for generating steam, distilling tar, evaporating liquors, or drying, it was led through an underground tunnel to a furnace, where it burnt with a flame from 6ft. to 10ft. high, 6ft. long, and 6in. thick.

In working with the chimney draught it had become apparent that the quantity of charcoal produced from the peat, as it passed from the top of the kiln to the fire-grate, was very much greater than was requisite for distilling off the tar from the subsequent charge of peat, and consequently there was considerable waste of time, besides other obvious disadvantages, involved in the combustion of this surplus fuel. Tó remove this obstacle to the increase of the quantity of peat worked in the kilns, an arched opening was made in each kiln, just above the fire-grate, and fitted with a door, through which the charred peat could be drawn out at intervals, in such quantity as to leave only just enough to serve as fuel for distilling the peat. This plan could not be regularly carried out during the last winter, on account of the danger of opening the doors of the kilns during high winds while the front of the kilns was unprotected by sheds. It was nevertheless found that by drawing out the surplus charcoal the quantity of peat worked was very much increased, and a very much more considerable advantage would have been gained in this respect if the removal of the charcoal could have been effected independently of the weather.

In illustration of the effect of these improved arrangements it may be mentioned that the quantity of peat worked was considerably greater than when working with the chimney draught, being in all cases upwards of 70 tons a week, and while the weather was favourable for drawing the surplus charcoal, upwards of 100 tons a week. The yield of tar was also increased to the extent of 7·5 per cent. of the peat worked, and was on the average as much as 7 per cent. The number of men required for working the kilns was also much smaller than was the case while working with the chimney draught. These results were in every respect very much more favourable than what had been anticipated at the outset, inasmuch as the cost of the tar, instead of being £5 per tou, was under £3 per ton, while on the other hand the quantity made per week, instead of being only 6 tons, was upwards of 7 tons, and was also in a fair way of being increased.

One of the products obtained from the peat tar was a burning oil of excellent quality, similar to paraffin oil and the oil obtained from American petroleum. It was sold last winter in Glasgow, under the name of lignole, and was examined by Dr. Anderson, who expressed his opinion that it would compare favourably with the best varieties of mineral oils obtained from coal. The production of this oil is an important feature of novelty in the working of peat.

The heavier oil obtained from the tar would burn very well, but it requires a different form of lamp from that generally employed now for the hydro-carbon or so-called paraffin oils. When mixed with fat oils it forms a good lubricator. Some samples of this oil, mixed in proportions suitable for the spindles of cotton machinery, were examiued by Dr. Rankine, of Glasgow, who reported on them as follows. The standard of comparison was sperm oil:—

"The following table shows the results, the oils being arranged in the order of their friction-reducing powers, as shown by the number of revolutions made by the spindle:—

	Relative lubricating power.	Number of Revolutions.
Oil No. 5	101	416
Sperm oil	100	411⅗
Oil No. 3	98	404
Oil No. 2	97	401½
Oil No. 1	85	349½

"The conclusions are that the oil No. 5 is somewhat superior to sperm oil as a lubricant, and Nos. 3, 2, and 1, somewhat inferior; but in the case of Nos. 3 and 2 the inferiority is only slight."

"I have not yet had an opportunity of testing by direct experiment the lubricating effects of these oils, or of compounds containing them, on the bearings of large and heavy machinery. The principal difference required in unguents for different kinds of machinery depends on the intensity of the pressure at the bearings;

the more intense pressures requiring thicker or more viscid unguents, that they may resist the tendency of the pressure to force them out. Additional thickness is given to an unguent, when required, by dissolving a sufficient quantity of solid greasy matter in the oil; and from previous observation of the properties of unguents containing oils analagous in their chemical character to those with which I have been furnished from the Lews Chemical Works, I am satisfied that the latter oils may easily be thickened in the same manner, so as to adapt them to any intensity of pressure at the hearings to which they may be applied."

The apparatus by means of which these oils was tested, as regards their application to cotton machinery, consisted of a cotton spindle, supported in a vertical position upon a pivot lubricated with the oil to be tested, and carrying a fly or revolving disc. This spindle is set in motion by a constant weight, descending through a constant height, and allowed to revolve freely until it stops of itself, the whole number of revolutious made before stopping being counted by the aid of suitable mechanism. The greater that number of revolutions, the more perfect is the lubrication produced by the oil; and, inasmuch as the bearing at which the friction is tested, is that of an actual cotton spindle, the results of the experiments give a peculiarly satisfactory test of the qualities of the oils for lubricating these hearings, and hearings of light machinery in general.

Having already referred to the Irish Peat Company's works, and to the results obtained there, I would now wish briefly to point what appears to have been the circumstances which contributed to the signal failure of that undertaking. Table III. contains a comparative statement of the results anticipated from the working of Irish peat, and of the results actually obtained.

TABLE III.

	1		2		3		4		5		6		7	
	Anticipated results from the working of Irish Peat, as set forth in the Company's prospectus, on the authority of Mr. Reece, 1851.	Value.	Sir Robert Kane's Report 1851.	Value.	Working Results with Irish Peat, as given in Mr Sullivan's Report to the Directors of the Irish Peat Company, 1855.	Value.	Retort Tar from Lews Peat, 1858.	Value.	Kiln Tar from Lews Peat, 1858.	Value.	Working Trial of 1 ton Kiln Tar from Lews Peat, 1858.	Value.	Working Result from Lews Peat since the Fan was used, 1861-62.	Value.
		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.
Quantity of peat worked 100 tons.		10 0 0	100 tons.	10 0 0	100 tons.	20 0 3	100 tons.	10 0 0	100 tons	10 0 0	100 tons	10 0 0	100 tons	10 0 0
Sulphate of ammonia ...... 20 cwt.		12 0 0	20 cwt.	12 0 0	3 cwt.	1 16 0								
Acetate of lime .... 14 cwt.		9 16 0	4 cwt.	2 16 0	—									
Wood naphtha, 5s. per gal. 52 gals.		13 0 0	52 gals.	13 0 0	10 gals.	2 10 0								
Crude oil, 1s. „ „ 300 gals.		15 0 0	300 gals.	15 0 0	—									
Paraffin, 1s. per lb.......... 300 lbs.		15 0 0	300 lbs.	15 0 0	300 lbs.	15 0 0	999 gals.	99 18 0	535 gals.	53 10 0	500 gals.	50 0 0	749 gals.	74 18 0
Refined oil, 2s. per gal.					150 gals.	15 0 0								
Creosote							330 gals.		560 gals.					
Total value of products		64 16 0		57 16 0		34 6 0		99 18 0		53 10 0		50 0 0		74 18 0
Cost of material & manufacture		32 2 0		32 2 0		34 3 4		Cost of working not ascertain'd		37 10 0		37 10 0		38 14 6
Balance		32 14 0		25 14 0		0 2 8				16 0 0		12 10 0		36 3 6
Value of oils and paraffin		30 0 0		30 0 0		30 0 0				53 10 0		50 0 0		74 18 0
Cost of material and manufacture		32 2 0		32 2 0		34 3 4				37 10 0		37 10 0		38 14 6
Balance		2 2 0		2 2 0		4 3 4				16 0 0		12 10 0		36 3 6

Together with these results are given, also, comparatively, the results obtained at the Lews works by myself.

The prices set down for peat, and for the products obtained from it, are the same in different cases, except in the statement of the working results of the Irish works in 1855. In that case the cost of the peat is set down as 4s. per ton, as reported in one of the official documents of the Company to have been the cost. The value assigned to the oil, in this case also, is not 5s. per gallon, as given in the Company's report, but 2s. per gallon, which I believe to be nearer its true value, and which admits of the results being compared with the other cases, in which that is the value set upon the oil.

The difference between the anticipated and the actual value of the ammoniacal salts, acetate. and naphtha, produced from the peat, is strikingly great, and I think it affords sufficient confirmation of the opinion I have already expressed as to the impropriety of regarding these products as constituting any source of profit in working peat, except when the manufacture of the other product is in itself remunerative.

But if these products are disregarded, the amount of oils and paraffin yielded by the Irish peat is so small, as compared with the cost of production, as to leave no possibility of profit. In addition to this it may be mentioned that the quality of the oil produced at the Irish works was very inferior, and bore no comparison to that of the oil produced at the Lews works. The manufacture of burning oil, indeed, was not attempted at the Irish works, in consequence of the offensive smell which the lighter portion of the oil possessed.

On the other hand, the yield of oils and paraffin from Lews peat is from three to four times as great as that obtained from the Irish peat, while the cost of working is but very slightly greater. The cost of peat in the two cases is also very different; for while in Lews the peat never cost more than 2s. 6d. per ton, and has since been obtained at a much lower rate, the cost of peat at the Irish works was 4s., and even as much as 6s. and 7s. per ton, a circumstance which in itself would be inconsistent with the possibility of working even such peat as that of Lews.

With these facts so clearly apparent, it is not a matter for surprise that the results obtained at the Irish works were not sufficient to afford a return for the enormous expenditure of capital on the works that were established; and to those who take an interest in the subject of peat working it must be a source of regret that the attempt to work the Irish peat was made and followed up with such rash precipitation and with so little preliminary examination of the capabilities of the material for working which such a large investment was made. Under any circumstances the working of peat is surrounded by many serious difficulties as regards both its establishment and prosecution. The districts where peat occurs are generally wild and remote, destitute of all those appliances and facilities for industrial operations which are to be met with in more cultivated parts of the country; the climate inhospitable and unfavourable for out-door work, and the inhabitants—accustomed to a rude mode of life, disliking work, and strenuously opposed to anything differing from their customary habits—are not easily trained to systematic labour. But these are not impassable barriers; they are merely obstacles which are to be overcome by patient perseverance, and, from the practical experience I have had of this subject during the last four years, I feel convinced that such peat as that occurring in the Western Islands and in the Highlands of Scotland, may be worked advantageously; and that, if the manufacture of these oils, which have now become such an important article of commerce, be carried out with earnestness and perseverance, it will become a means of greatly improving the condition of those districts in every respect, and a fertile source of profit to those who carry it out.

Shipping Statistics.—The following table supplies the number and tonnage of all registered vessels, both sailing and steam-propelled, belonging to each division of the United Kingdom. together with the number of the crews employed in navigating the same, in each of the five years from 1857 to 1861, inclusive:

		Vessels.	Tons.	Crews.
England	1857	20,485	3,594,687	167,806
	1858	20,868	3,675,181	168,603
	1859	21,032	3,694,267	168,843
	1860	21,007	3,709,615	168,415
	1861	21,434	3,862,384	173,200
Scotland	1857	3508	639,557	32,165
	1858	3543	652,675	32,862
	1859	3513	646,412	32,737
	1860	3486	623,791	31,682
	1861	3410	625,127	32,039
Ireland	1857	2226	257,133	14,467
	1858	2247	260,037	14,289
	1859	2259	250,511	13,971
	1860	2271	253,336	14,109
	1861	2298	247,080	13,960
United Kingdom	1857	26,219	4,491,377	214,407
	1858	26,658	4,587,893	215,754
	1859	26,804	4,591,250	215,551
	1860	26,704	4,586,742	214,206
	1861	27,142	4,735,491	219,199

REVIEWS AND NOTICES OF NEW BOOKS.

Every Man's own Lawyer: a handy book of the principles of Law and Equity, comprising the rights and wrongs of Individuals, &c. By a Barrister. London: Lockwood and Co., 1863.

When Sugden the eminent lawyer produced a work somewhat similar to the one under notice, he was, we believe, the first who successfully condensed in a readable shape for non-professional men the principles of law and equity, in connection with the every day relations of individuals; but he very properly avoided the error of recommending every man to become his own lawyer.

The object with which the first work was written, has been very successfully carried out, and the vast number of subjects of which the book treats are very clearly placed before the reader.

This book must prove of great service to men of business, and we think "A Barrister" has not done himself full justice in the statement that the "price 6s. 8d. may be saved at every consultation," for we believe that a timely reference to this work may save the possessor from ruinous entanglement in the meshes of the law,

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A Practical Treatise on the Law relating to Mines and Mining Companies. By Whitton Arundell, Attorney-at-Law. London: Lockwood and Co., 1863.

This is another of the "handy books" relating to the special laws affecting Mines and Miners, and the author has brought together, in a conveniently small compass, a vast amount of valuable information on the nature of the property in mines, and its transfer; on mining partnership of various forms; on the working of mines, and the rights of owners and others. Of the rights of water and way; the rating of mines; of the Stannaries Court and its jurisdiction, and numerous other important and interesting matters in which most of those interested in mines, either as owners or investors, are deeply concerned.

Mr. Arundell's book should be possessed by every one interested in British Mines.

Contribution towards a History of Electro-Metallurgy, establishing the origin of the Art. By Henry Dircks, C.E. London: E. and F. N. Spon. 1863. Crown 8vo., pp. 120.

We have in this volume a collection of the papers written by Mr. Dircks during the years 1844-52 in various publications.

Professor Jacobi appears to have discovered a means of engraving by galvanism, and Mr. C. J. Jordan, of Liverpool, communicated a process he had invented for that purpose, and which, it is said, he published on the 8th of June, 1839. It also appears that Mr. T. Spencer wrote to the Liverpool Polytechnic Society on the 9th of May, 1839, stating he had an invention which he considered to be similar to Jacobi's, and that he would shortly communicate it, which promise he fulfilled, but not until the 12th of September, 1839. Mr. Dircks does champion for Mr. Jordan most valiantly, in the course of which the history of electro-metallurgy, and more particularly the special branch of that science to which we have alluded, is admirably brought out.

We consider that Mr. Dircks's work will for ever settle the question, and stamp Mr. C. J. Jordan, printer, as the true and first inventor of electro-metallurgy, through his publication of the process, on the 8th June, 1839. Mr. Dircks combats the question vigorously in all its minute ramifications, with candour, always keeping to the main point. It is not often that such investigations are carried through with equal good temper; and, considering it commenced in 1844, had to be taken up again in 1852, and is now published as a matter of scientific history, it is evident that Mr. Dircks is quite at home in this subject. We commend a perusal of the work to our readers.

The History of the Sewing Machine from the Year 1750. By N. Salamon. London: 8, Ludgate Hill, 1863.

In a pamphlet of over 100 pages, the author has given a history or biographical sketch of Mr. Elias Howe, the American inventor of the Sewing Machine which was first introduced into this country by him, but patented and known as Thomas's Machine, and which machine has since been improved upon and introduced to an enormous extent for sewing and manufacturing fabrics, and articles of almost every description.

The history of the Howe Sewing Machine in particular, and Sewing Machines in general, is one of great interest. Mr. Saloman attacks the present condition of the law relating to Patents for Inventions, and some of his strictures are deservedly, yet properly severe, but he is nevertheless a little at sea in this branch of his subject, whilst he is quite at home when he confines himself strictly to the history of the sewing machine.

NOTICES TO CORRESPONDENTS.

Aspel.—The vessel is fitted with Messrs. Randolph, Elder and Co.'s patent inverted cylinder engines, with internal gearing (iron). There are four cylinders (steam jacketted), viz. two of 62 in. diameter, and two of 31 in. 3ft. 3in. stroke. The piston makes 40 strokes per minute, and the screw makes 100 revolutions per minute. There are two tubular boilers 10ft. diameter, 16ft. long, fired at both ends, fore and aft, total heating surface, including super heater, 4200ft. There are eight furnaces, 3ft. wide by 4 ft. long; total fire grate area 96ft.; temperature of steam, 320°; pressure of steam, 37lbs.; vacuum in condenser, 28in.; surface in ditto, 2400ft.; tubes ⅝in. diameter, 6ft. 6in. long.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

General Steam Navigation Company *v.* Mare.—This action was brought against the defendant, who formerly carried on business as a shipbuilder at Millwall, for breach of contract, by which he agreed to build a certain ship for the plaintiffs. The defendant became a bankrupt, but the bankruptcy was annulled, and he entered into a deed of arrangement with his creditors. At the trial, which took place at the Guildhall, before the Lord Chief Baron, a verdict was returned for the plaintiffs—damages, £290 8*s.* 8*d.* for stores, £709 17*s.* paid to his assignees for finishing the vessel, and £700 for penalties of £10 each for 70 days. The case now came before the Court upon a rule for a new trial, and in the course of the arguments it was agreed between the parties to draw up all the facts in the shape of a special case, and to bring it on again for argument.

Willis *v.* Davison.—In this case a rule nisi had been granted for a new trial. It was an action brought against the defendent to recover damages for the infringement of the plaintiff's patent for improvement in the manufacture of organs. The action was tried at Guildhall before Lord Chief Justice Cockburn, when the verdict was entered for the plaintiff, subject to leave reserved to the defendent to move to enter the verdict for him. The objects sought to be obtained by the invention were to give a rapid utterance to organ pipes of large dimensions with a decreased expenditure of muscular power on the part of the organist; to improve the effect of the swell organ, and bring the tones of the pipes in the swell box under more pefect command than heretofore; to steady the action of the bellows, levers, drawstops, swell shuttters, composition pedals, and like moving parts, and to prevent all unnecessary friction between vibrating arms and levers, and their bearings or chases—to bring the stops more thoroughly under the command of the performer, so that he could effect a variety of changes by putting in or drawing out such stops as might be required without the use of pedals as heretofore, and without removing his hand from the keyboard, and, lastly, to effect a saving of space, by improving the arrangement of some of the internal parts of the organ. After hearing the lengthened arguments of the learned counsel on both sides. The Court made the rule absolute to enter the verdict for the defendant. Rule absolute accordingly.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts (for which we are chiefly indebted to the *Chemical News*), Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Machine Belting.—Messrs. Spill and Co., of Hackney Wick, have taken out a patent for machine belting, the peculiarities of which are that it is made of the best flax yarn, and woven into one solid mass by powerful steam-power looms, all this warp, or shuttle twine, being first soaked in water, so that the rack, on shutting the warp up into its place, may not meet with any of the opposition that hard yarn would present. The belting is made in three substances, and India rubber, of the very best quality, is passed on to the band while it is travelling through rollers, so that the gum may be squeezed into every opening, or partition, between the mass, thus rendering the whole more pliable, stronger, and about half the price, in wide bands, than is paid for leather. The bands in question can be laced with a common thong, in the same way as leather, and are equally free from trouble. No 3 substance has 90 warps to the inch, and each warp is capable of sustaining a strain of 50lbs. Official experiments applied to these bands testify to the above facts.

Preparing Iron Plates, &c.—The three months' trial of Mr. Roper's method for preparing iron plates, and of his composition for preventing the oxidisation of plates used for ships, having been concluded at Portsmouth, the test-plate, which had been immersed during the above-named period, was raised to ascertain its condition after the lengthened immersion. The result was most satisfactory to the inventor, and the plan was proved a success. The side prepared according to Mr. Roper's plan presented almost the same clean and even surface as it did when first immersed, while the reverse side, not having been prepared, was considerably corroded, thus proving the necessity of using the composition.

Asphaltum Oil.—Mr. Dollfus has discovered that the heavy oil, extracted from the asphaltum and bitumen of peckelbroun, is the best and most economic substance for preventing the incrustation of steam boilers. A thin coating of the oil is painted over the interior of the boiler every time the boiler is cleaned. By this means incrustation is entirely prevented, less fuel is required to keep up the steam, and the boilers do not burn out so fast.

TRIAL OF STEAM FIRE ENGINES.—On the 15th ult., an interesting trial of the "Deluge" and Torrent, two engines constructed by Messrs. Merryweather and Son, took place at the West Ham Abbey Print Works, where every facility for this purpose was afforded by James Kaycess, Esq., the proprietor. The "Deluge" is the engine which was exhibited in the International Exhibition last year, and the Torrent is a new engine of the class denominated "light steam fire engines" by the manufacturers. This engine can be easily drawn by a few men or one horse, more rapidly by a couple of horses, and has a cylinder $6\frac{3}{4}$in. diameter, with a 12in. stroke, the pump being double-acting, $4\frac{3}{4}$in. diameter, with the same stroke as the steam piston; and, by a simple arrangement of the oiling apparatus, the piston lubricates itself at each stroke. The water passages and valves are placed beneath the pump, are easy of access, and there is no fear of freezing. They will allow the use of foul water without obstruction. The engine has no fly-wheel, but the slide is moved by a very ingenious arrangement, which enables a very slow or very quick movement of piston to be obtained at pleasure. The boiler is constructed in accordance with Messrs. Merryweather's patent, and does not prime. It has an injector for feeding, and can also be fed from the main pump. This engine is mounted on a strong wrought iron frame, and is attached to the fore carriage in such a manner that it can be taken over the roughest roads with ease and safety, and its high wheels and springs make it less liable to injury frem rough work. Means are provided for carrying hose, suction pipes and all the necessary apparatus, with room for the men to ride, and it has coal bunkers and a water tank provided, so that it takes a sufficient supply of both to insure no loss of time in getting to work. The first trials were made at 9·30 a.m., when the Torrent, lifting the water between 5ft. and 6ft. (as did also the Deluge), worked through jets of 1in. and $1\frac{1}{8}$in.—also through two, one of $\frac{3}{4}$in. and one of $\frac{5}{8}$in.—giving good proof that good work would be done through two $\frac{7}{8}$in. jets. The pressure in the pump never exceeded 120lb., and that in the boiler averaged from 130lbs. to 140lbs. The chimney at the works, 120ft. high, was easily topped by this engine through a $1\frac{1}{8}$in. jet, although the wind was blowing fresh. This engine did good work with a $1\frac{1}{4}$in. jet, which would have been very efficacious at a fire. Air vessels are fitted on each delivery, and near the suction pipes outlets are provided for attaching two lines of hose; and the engine will throw 250 gallons of water per minute to 160ft. in height. The following is the time and pressure of steam in the boiler from lighting the fire:—In $6\frac{3}{4}$min. pressure gauge moved; in 8 min., steam $2\frac{1}{2}$lb.; in 8min. 30 sec., steam 5lb.; in 9 min. 10 sec., steam 10lb.; in 10 min., steam 20lb.; in 10 min. 15 sec., steam 25lb.; in 10 min. 30 sec., steam 35lb.; in 10 min. 45 sec., steam 45; in 11 min., steam 50lb.; in 11 min. 30 sec., steam 60lb.; in 11 min. 40 sec., steam 70lb.; in 12 min., steam 80; in 12 min. 10 sec., steam 90. The engine would have had steam much quicker had not the stop valve been kept open to warm the cylinder, which caused, in consequence, a rapid condensation of the steam. The Deluge threw a perfect column of water nearly half as high again as the chimney, the jets used being $1\frac{1}{4}$in., $1\frac{3}{8}$in. and $1\frac{1}{2}$in., all of which seemed to attain about the same height, and the pressure in the pump varied from 130lb. to 140lb., and that in the boiler from 120lb. to 130lb. The engine worked through four jets, each $\frac{7}{8}$in. diameter, and had time permitted it was intended to have used four of $\frac{7}{8}$in., as it was plain that there was steam power over and above what would have been required for them. In $7\frac{1}{2}$ min. from lighting the fire the gauge moved; in 9 min., steam 10lb.; in 10 min., steam 20lb.; in 10 min. 30 sec., 25lb.; in 11 min., steam 30; in 11 min. 30 sec., steam 40lb.; in 12 min. 10 sec., steam 50lb., when the engine started to work. An illustration and detailed description of the "Deluge" will be found in our series of ARTIZAN INTERNATIONAL EXHIBITION SUPPLEMENTS.

NEW REGULATOR FOR TEMPERATURES.—A Committee of the French Academy of Sciences reports very favourably of a new automatic temperature regulator which M. Eugene Rolland has attached to his mechanical roaster, and which, the committee say, has worked for eight years with the precision of a piece of physical apparatus and the certainty of a practical machine. The combustion of the furnace is regulated by balance valves on the pipes through which the air is introduced, which valves are automatically governed by the regulator. This regulator consists of a mercury guage, the closed branch of which is attached to a fixed support, while the cistern is freely suspended to the beam of a balance; the varying weight in this branch will cause the beam to assume different positions, depending on the temperature of the apparatus, which variation of position may be used to govern the valve. In order to prevent the barometric changes from affecting the apparatus, the closed end of a syphon barometer (the tube of which is of the same diameter with the guage) is attached to the beam, while its cistern is sustained by the fixed support. The barometric changes will then effect these two instruments equally and in opposite directions, and will, consequently, have no effect on the position of the balance beam.

BRAY'S RECENTLY MADE TRACTION-ENGINE.—A series of experiments have been made at Woolwich Dockyard before the principal officials with a view to test the efficiency of a new traction-engine, manufactured especially for dockyard work. The machine is at once a traction-engine, a steam derrick, and a portable steam-engine, and cannot, therefore, fail to prove economic in use. The total weight of the engine, boilers, and appliances complete is but 12 tons, and the pressure of steam which can be used is 120lbs. The cylinder is 7in. in diameter, and of short stroke, and the efficiency of the whole machine was really remarkable—a boiler of 28 tons weight being moved about, with the greatest facility by the use of the truck, whilst the derrick proved itself capable of raising between two and three tons with ease. It was shown that 10 miles per hour could be attained either on hard or soft ground. If, however, we are not mistaken, Mr. James Taylor, of the Britannia Works, Birkenhead, some time since constructed a machine which has been found to give very satisfactory results, and which appears to us to be nearly identical with this latest modification of Bray's traction-engine.

EXPORTS OF STEAM ENGINES.—According to the trade and navigation returns just published, an increase has been effected in the number of steam engines made and exported. In ten months ending October 31, last year, the value of steam engines sent abroad was £1,288,054. The value of the export in the ten years ending 1861, was as follows:—1852, £338,222; 1853, £458,376; 1854, £566,768; 1855, £883,370; 1856, £819,067; 1857, £1,089,249; 1858, £1,097,278; 1859, £973,340; 1860, £1,238,333; 1861, £1,243,467. It results from these figures that British steam engines were never in greater demand abroad than at present.

MILLWALL IRONWORKS.—Under the name of the "Millwall Ironworks and Shipbuilding Company" an association has been formed with £300,000 capital, which is all subscribed, to work with efficiency the extensive shipbuilding yard and rolling mills hitherto carried on by Mr. C. J. Mare, at Millwall. The yard where the *Great Eastern* was built, and which was purchased last year by Mr. Mare, forms a part of the premises of the new company.

CAPTAIN INGLIS'S TARGET.—About six months since, the result of experiments carried out at Shoeburyness, to test a target invented by Captain Inglis, attracted much attention from the fact that it was found capable of resisting rifled ordnance of a description which had easily pierced the strongest combination of iron plates and timber backing. Captain Inglis, having recently constructed a target with certain improvements, it has been subjected to a series of experiments, and a report has been made to the war department, highly favourable to the invention. The target consists of iron plates or bars placed across each other on a timber backing, and it has hitherto been scarcely affected by repeated attacks from Armstrong and Whitworth guns.

NEW DOUBLE-ACTING PUMP.—On the 10th ult. a series of experiments, with a view of testing the efficiency of the double-acting pump and fire-engine, invented by Mr. Delpech, were made at the wharf of Messrs. Francis, Son, and Potts, at Nine Elms. The arrangement of the apparatus consists of an external metallic casing, divided into two distinct portions, the one containing the cylinder in which the piston moves, and which is called the cylinder chamber, whilst the other contains four elastic balls, acting as valves or clacks, and is called the ball chamber. The cylinder chamber is divided into two parts by a diaphragm. This partition is provided at its centre with a round opening for the cylinder, which is open at both ends, and between its extremities and the chamber ends a space is left for the circulation of the liquid. The ball-chamber is also divided internally into two equal compartments by a vertical partition, each, however, communicating by a wide opening with one of the compartments of the cylinder. The principal feature of the pump, however, is the piston, which consists of two flexible cups, turned back to back, and kept in position by metal plates, considerably smaller than the diameter of the cylinder. The object of this arrangement is to reduce friction to the minimum. The advantages claimed for the pump are—that the liquid undergoes no interruption of motion from the dead point; that its effective force is extraordinary, as it yields nearly 70 per cent., and that mixture of ore, rags, or other foreign matter with the water does not interfere with its working, all things not exceeding one-half the diameter of the suction-pipe being easily pumped through. It will at once be seen that the principle of the pump is precisely the same as that involved in Warner's double-acting pump, and Godwin's flood-pump, as well as some others; but Mr. Delpech has introduced modifications, or improvements, in the piston, which cannot fail to pack very tight, and in the substitution of ball-valves for the usual clack-valves.

NAVAL ENGINEERING.

THE COLUMBINE, 4, screw steam gunvessel, 200-horse power has been taken out of the fittting basin at Sheerness, and after being fitted with Lumley's patent steering apparatus, was on the 23rd ult. taken to the measured mile off Maplin Sands for trial. The vessel was in charge of Capt. Charles Wise, A.D.C., Captain Superintendent of Sheerness Dockyard. As previously reported in *The Artizan*, the *Columbine* was fitted with the ordinary rudder and taken out on trial on the 16th of December last. This was with a view to compare the results. At the first trial, with the old rudder, at full speed, helm starboard, at an angle of 23 deg., the circle was made in 4 min. 26 sec.; with the new rudder, helm starboard, at an angle of 17 deg., the circle was made in 4 min. 10 sec. At the second trial, with the old rudder, from dead stop, helm starboard, at an angle of $35\frac{1}{2}$ deg., the circle was made in 4 min. 30 sec.; with the new rudder, at an angle of 30 deg., the circle was made in 4 min. 15 sec. At the third trial, with the old rudder, at full speed, helm port, at an angle of $18\frac{1}{2}$ deg, the circle was made in 5 min. 5 sec.; with the new rudder at an angle of 18 deg., the circle was made in 4 min. 10 sec. At the fourth trial, with the old rudder, from dead stop, helm port, at an angle of 32 deg., which fell off to 27 deg., the circle was made in 4 min. 28 sec.; with the new rudder, at an angle of 30 deg., which fell off to 26 deg., the circle was turned in 4 min. 20 sec. At the fifth trial, with the old rudder, at full speed, helm starboard, at an angle of 11 deg., the circle was made in 7 min. 48 sec.; with the new rudder, at an angle of 10 deg., the circle was made in 5 min. 40 sec. At a similar trial with the old rudder, with the helm to port, the circle was made in 7 min. 20 sec., and with the new rudder in 6 min. 40 sec. The comparative diameters of circles were:—Second trial, with old rudder, 818ft.; new rudder, 625ft. Third trial, old rudder, 1,450ft.; new rudder, 782ft. Fourth trial, old rudder, 551ft; new rudder, 291ft. Fifth trial, old rudder, 673ft.; new rudder, 468ft. When testing the power of the old rudder the trial was made on a calm day, and with little or no wind. The trial of Lumley's rudder on the 23rd ult. was made in a heavy sea, with a heavy gale of wind blowing from SS.W., the force of wind being from 7 to 8. Capt. Wise, with a wish to test the strength of the new rudder in the most efficient manner possible, turned the *Columbine's* stern up to the wind in the teeth of the gale then blowing and against the heavy sea, and directed the ship to be steamed astern full speed, which the rudder auswerd in a most admirable manner, proving the strength and efficiency of the invention when applied to heavy and powerful vessels, and under the most unfavourable circumstances. The most marked improvement was evident when the small helm was given, such as 11 or 12 deg., the Lumley rudder then gaining as much as two minutes in describing the circle over the old rudder. The diameters of the circles—the true test of the efficiency of a rudder—were found to be in some cases as much as 50 per cent. in favour of the Lumley invention. The trial was considered most satisfactory.

THE "PYLADES," 21, 1278 tons, has taken her final trial trip, at the measured mile off Maplin Sands, previous to her departure to the West Indies. The *Pylades* is fitted with Penn's horizontal direct-acting trunk engines, of 350-horse power, which worked extremely well. There was an entire absence of all hot bearings, priming, or any perceptible vibration from the machinery. The results of the trial were:—Average speed, 10·373 knots per hour; revolutions of engines, 63; vacuum, 25; pressure of steam, 20lbs. Griffith's screw, pitch, 20ft.; diameter, 15ft. 9in.; draught of water forward, 15ft. 9in aft, 19ft. 7in.

FRENCH NAVY.—The following is taken from the report of the French Minister of the Marine. At the present time the number of steam vessels of war composing the active fleet amounts to 136, including the 24 gunboats afloat; but, only taking into account the five desciiptions of vessels set down in the tables of 1862, the number is only 112, divided as follows:—

	New Vessels.	Mixed Vessels.	Totals.
Line of Battle Ships,	13	23	36
Iron cased Frigates,	4	—	4
Ordinary Frigates,	18	6	24
Corvettes,	7	—	7
Advice Boats,	41	—	41
	83	29	112

The above list gives for the new fighting fleet an increase of 11 vessels completely fitted out, viz:—one line of battle ship, of 900 horse power, which has been a long time on the stocks; two iron cased frigates; three ordinary frigates; and six advice boats. But on the other hand one vessel has been lost at sea, and eight belonging to the old fleet have been condemned as no longer fit for service. Lastly, there are afloat, nearly completed, or making experiments, two iron cased frigates, one ordinary frigate, two advice boats, one gunboat, and two floating batteries.

THE "PRINCE ALBERT."—A large number of workmen are now employed at the premises of Messrs. Samuda upon the construction of Her Majesty's armour-plated screw cupola ship *Prince Albert*. She will be iron cased throughout with $4\frac{1}{2}$in. plates, and fitted with four armour cased shields or cupolas, of immense strength, upon Captain Cole's plan recently adopted by the Admiralty. She is the first cupola ship laid down for the government, and is named the *Prince Albert* by express desire of Her Majesty. The armament of this magnificent vessel will consist of eight monster rifled guns, two of which will be fitted in each cupola.

THE RUSSIAN GOVERNMENT has commenced the development of an iron navy. Messrs. C. Mitchell and Co., shipowners of Newcastle-on-Tyne, have been entrusted with all the arrangements necessary to convert the Government dockyard at St. Petersburg into an iron shipbuilding yard. Steam engines, punching, shearing, and other machines of the most modern construction, have been sent from Manchester and London. A railway will traverse the dockyard and communicate with the workshops and building slips. Steam travelling cranes will be erected over the vessels in course of construction, thus performing the greatest amount of work by means of mechanical appliances.

Loss of the Monitor.—This famous American iron clad cupola steamer foundered at sea, south of Cape Hatteras, in a heavy gale on the 29th December last, whilst on her voyage to one of the Southern Ports. We have, on another page, given two illustrations of this vessel.

Screw of the "Royal Oak."—This iron clad frigate shipped her spare screw, at Chatham dockyard, on the 17th ult. The screw-blade of the propeller is Griffith's, which by a recent decision of the Admiralty, is now supplied to all screw ships of war. In the case of the *Royal Oak*, however, the screw has been subjected to some alterations and improvements by Messrs. Maudslay, the most important of which appears to consist in bolting the screw blades to the "boss" with flanges instead of fixing them with the key and wooden wedges. By this arrangement the blades are more securely attached, while the pitch of the screw may be readily varied when required, an advantage not to be obtained in the present construction and fittings of Griffith's screw. The diameter of the screw is 19ft. 3in., and by the improvements introduced its pitch can be easily and rapidly varied from 22ft. 6in. to 27ft. 6in., with an ordinary pressure of 20lb. of steam to the square inch. The screw will make 60 revolutions per minute. The length of the iron shaft for working the screw is 109ft., and the weight of the screw 19¼ tons.

The New Yacht ordered to be constructed for the use of Her Majesty when at Osborne will be built at Pembroke Dockyard, according to designs furnished from the office of the Controller of the Navy. She will be propelled by paddles driven by engines of 160-horse power, from the manufactory of Messrs. J. Penn and Son, will be of considerably more tonnage than the *Fairy*, and will have a somewhat different midship section from that vessel. The *Fairy* has stood unrivalled for a number of years past, either in beauty of form or rate of speed, but the peculiar roundness of her bottom has rendered her a very uneasy vessel in crossing Spithead during a south-east breeze. Her Majesty has experienced much inconvenience and personal discomfort at times in consequence. The *Victoria and Albert* large paddle yacht has been used on several occasions to convey the Queen when there was very rough weather, but, as she could not approach either of the landing places at Cowes or Haslar, the *Fairy* had still to be retained as a means of transport to and from the large yacht. This again has been a cause of much personal discomfort and delay to Her Majesty. The new yacht will supply the means of crossing between the Isle of Wight and the main, under any circumstances of weather, in comfort and in safety.

Iron-built Armour-Plated Vessels.—On the 19th ult., Mr. T. Barras read a very interesting paper in the theatre of the Royal United Service Institution, on the proposed plan for a wholly iron-made armour-plated vessel. Captain Fishbourne, R.N., occupied the chair. The view taken by Mr. Barras of the subject was of a three-fold character. He said that a ship such as he proposed should be regarded hydrostatically, as a body designed to float; mechanically, as a beam subject to great pressure; and in the third place as a battery designed for purposes of attack and defence. A ship to be constructed on his principle should have a flat bottom amidships, where the boilers and coal bunkers were, and should be constructed wholly of iron, in three sheets of iron plates, riveted together in such a manner as to be protected either by an outer or inner coat of the plating. He strongly objected to a ship built of mixed materials differing widely from each other in chemical properties, as they never could work in harmony together. One point connected with the present construction of ships demanded consideration, and that was the destructive electrical action which took place in salt water with mixed constructions of iron and wood, with fastenings of brass. It was this electrical action that caused the high ratio of illness occurring in the finest armour-plated ships, and the curious results elicited by *La Gloire*. As for the present system of shipbuilding, the probable results might be anticipated—the most serious and ruinous expenses would be gone to on ships that could not be expected to last for a dozen years; while a ship constructed as he proposed, he ventured to affirm would be an efficient ship for half a century, if not longer. Mr. Barras entered into particulars, tending to show that the vessel thus put together would answer all purposes for which she would be required.

Ventilation of Iron-cased Frigates.—The plan of ventilation which is now being carried out on board the frigate *Royal Oak*, under the direction of Capt. Fanshawe, who is the inventor of the system, differs in several respects from the method hitherto adopted for securing ventilation for our large line-of-battle and other ships. As applied to the *Royal Oak*, and other armour-plated vessls of the same class, it promises to be exceedingly effective. In securing a ventilation of the main deck, comparative little difficulty will be experienced; it is therefore in the lower deck that the method recommended by Capt. Fanshawe will be more particularly adopted. The masts of the *Royal Oak*, being of iron, and all hollow, advantage is taken of this to make them air-shafts for carrying off the vitiated air from each deck. An aperture is accordingly made in each mast, which being opened and closed at pleasure, permits the foul air of all the decks to be carried upwards. The different berths, stores, and compartments on the deck, instead of being closed up as in ordinary vessels, are supplied with gratings by which the foul air may escape. The essential point in Capt. Fanshawe's system is that there shall be a constant current of air circulating in every portion of the vessel, approximating as closely as possible to the upward and downward currents of a mine.

The Danish Navy.—A list of the Danish navy and its officers has lately been published, from which is derived the following information. The Danish fleet, which for the last year has been growing in numbers, has now began to diminish on account of the sailing vessels being given up altogether, and partly sold, and partly going to be sold. There only remains two ships of the line, two frigates, two sloops, two brigs, and one cutter. Of screw propellers there are in the water, one ship of the line of 64 guns, four frigates of respectively 44, 42, 42, and 34 guns, three sloops of 16, 16, and 12 guns; two iron-clad schooners and one wooden schooner, each of 3 guns; further, six iron screw gun boats, each of two guns; eight paddle steamers, with from 2 to 7 guns; and 50 guns boats, and 28 transport ships. Moreover, the former ship of the line, *Dannebrog*, is being altered into an iron-clad screw sloop of 400-horse power, with fourteen 60lb. guns, and one heavier gun; and the screw frigate *Peder Schram*, of 600-horse power and 66 guns, and a screw schooner of 150 horse-power and 3 guns, are far advanced. The corps of officers numbers 4 admirals, 29 captains, 23 lieutenant captains (commanders), and 85 lieutenants.

The Royal Navy.—The following statement of the condition of the Royal navy at the present time has been compiled from authentic sources. It shows that there are 287 vessels in commission, doing duty in various parts of the globe. The total number of vessels is made up as follows: 5 iron screw ships from 16 to 40 guns each, 3 iron-cased ships of 34 guns each, 1 iron-cased screw cupola ship of 5 guns, 67 screw ships from 31 to 131 guns each, 37 screw frigates from 6 to 51 guns, 26 screw corvettes from 13 to 22 guns, 36 screw sloops from 4 to 17 guns. 4 screw floating batteries from 14 to 16 guns, 4 screw mortar ships of 12 guns each, 2 iron screw floating batteries of 16 guns each, 1 iron screw sloop of 8 guns, 1 iron paddle sloop of 6 guns, 1 iron screw yacht, 1 iron screw troop ships from 1 to 8 guns, 6 iron screw store ships ftom 1 to 4 guns, 15 iron paddle vessels from 1 to 6 guns, 1 iron screw vessel, 1 screw surveying vessel of 5 guns, 47 screw gun vessels from 1 to 6 guns, 1 screw store ship, 26 paddle vessels from 1 to 6 guns, 27 paddle sloops from 3 to 6 guns, 15 paddle frigates from 6 to 28 guns, 4 paddle yachts, 2 paddle store ships of 4 guns each, 1 Royal yacht, 3 paddle surveying vessels, 10 paddle tug vessels from 1 to 3 guns, 2 paddle gun vessels of 3 guns, 134 sailing ships, 160 screw gun-boats, 141 non-effective ships, hulks, &c., engaged in harbour service, and 48 coast-guard tenders. The ships now building comprise: 5 iron screw ships, 4 iron cased screw ships, 1 iron cased screw cupola ship, 1 iron cased screw corvette, 1 iron cased screw sloop, 3 screw ships, 4 screw corvettes, 6 screw frigates, 6 screw sloops, 5 screw gun-vessels, 9 screw gun-boats, and 2 paddle despatch vessels.

Naval Appointments.—The following Naval appointments have taken place since our last:—B. Foreman, Engineer, to the *Osprey*; J. Hill, Engineer, to the *Cumberland*, as supernumerary; J. Stiven, in the *Edgar*, promoted to Engineer; J. P. Lloyd, in the *Sanspareil*, T. Burnett, in the *Asia*, J. Turner (B), in the *Galatea*, W. Todner, in the *Cumberland*, A. Waters, in the *Swallow*, E. Eckersley, in the *Hastings*, for the *Lark*, W. Fedarb, in the *Porcupine*, J. T. Page, in the *Hastings*, for the *Sandfly*, and H. Knight, in the *Hawk*, promoted to the rank of Engineers; W. Inglis (A) and J. R. Hancock, First-class Assist. Engineers, and J. M. Brankston, Second-class Assist. Engineer, to the *Osprey*; C. M. Keever, First-class Assist. Engineer, and W. M'Glasban, Second-class Assist. Engineer, to the *Cumberland*; W. H. Wheatley, First-class Assist. Engineer, to the *Fox*; J. M. Murphy, First-class Assist. Engineer, and C. Wakeman, Acting Second-class Assist. Engineer, to the *Majestic*; R. Sampson, Chief Engineer, to the *Sampson*, for the *Prince Consort*; J. Ashley, Chief Engineer, to the *Asia*, for the *Arrogant*; J. Barr, supernumerary in the *Asia*, promoted to First-class Assist. Engineer; T. Huard, engineer to the *Caradoc*; W. Todner, Engineer to the *Cumberland*, for the *Bullfrog*; J. Donne, Engineer, to the *Triton*; J. Bowman, and J. Gissing, First-class Assist. Engineers, and W. Hopkins and J. Kelly, Second-class Assist. Engineer, to the *Caradoc*; C. Bulford, First-class Assist. Engineer, to the *Asia*; F. W. Robinson, First-class Assist. Engineer, and W. Walker, Second-class Assist. Engineer, to the *Triton*; R. E. Ramsay, Acting Second-class Assist. Engineer to the *Triton*; J. G. Bain, in the *Wesser*, promoted to Acting First-class Assist. Engineer; R. Holman, Chief Engineer to the *Alecto*; C. M'Keever, Fist-class Assist. Engineer, and W. M'Glasban and F. S. Scott, Second-class Assist. Engineers, to the *Alecto*.

MILITARY ENGINEERING

Practice against Armour Plates.—Some interesting firing at 4½in. and 5½in. armour plates, took place at Portsmouth on the 21st ult. The plates to be tested comprised, one from the Atlas Iron and Steel Works, Sheffield, (Messrs. John Brown and Co.,) and two from the Millwall Iron and Shipbuilding Company's Works, (late C. J. Mare & Co.) The first was a 4½in. plate for Mr. Reed's iron-cased corvette *Enterprise*, 9ft. 4½in. in length, and 3ft. 7in. in width. The Millwall plates were sample plates for the *Northumberland*, building in that yard, and were 5½in. thick, one inch in excess of the Atlas plates. One plate was annealed, and 8ft. 3in. in length by 3ft. 2½in. in width. The other plate was "tempered," and, with the exception of 1½in. less in width, was of the same dimensions as the one annealed. All the plates were bolted on to the side of the *Powerful*, target-ship, in Porchester-creek, and the firing was made from the *Stork's* 95cwt. 68-pounder smooth bore gun, at the customary 200 yards' distance. One shot was first fired at each plate in its turn, when the firing was suspended to allow of an examination being made of the effects produced. The annealed plate was found to have been struck by the shot 17in. from its upper edge at its left extremity, the depth of the indent being 2in., with a diameter of 9in., a crack extending across the corner of the plate from the line of the first square to the bottom line of the same square, or central line of the plate. Another crack was visible below the circumference of the indent, about 5in. in length. The tempered plate was struck in the bottom corner of the second square and had buckled outward at either end to the blow, but was without cracks. The depth of the indent was 1in. and 9-10ths, and the diameter 9in. There were no visible cracks. The 4½in. plate from the Atlas Works was struck on its left centre, the indent being, in this case also, 1in. and 9-10ths, and the diameter 9in. The plate was not buckled, and only a slight appearance of separation of metal was visible, and that was in the centre of the plate struck, and was apparently the outer surface of the metal rubbed up by the blow. From this the firing was carried on at each plate, with intervals between to allow of the necessary examination, until the two Millwall plates had each received five shots on their left ends from the centre, the Sheffield Atlas plate eight shots in the same quarter. The Millwall plates proved, as had been expected by their makers, incapable of resisting the blows of the 68-pounder; and separation of metal, as well as penetration of the ship, in their case was perfect. With the Atlas plate the case was more satisfactory. The plate proved of excellent quality, and, although subjected to severe straining blows on its left edge and lower left corner, and to six blows all delivered within a very small space, and in two instances overlapping each other, there were no cracks from individual blows to bolt holes or other weak parts. The separation of metal that took place, irrespective of the edge and corner blows, was caused by the pounding of the shot in one particular space, and the consequent tearing asunder of the metal. The ship's side was clear of anything like penetration. The plates from Millwall were stated to be purely experimental, which, it is also asserted, fully accounts for their failure. The work is new to the company, and, as they are about to embark largely in it, even the failure of a few plates may be turned to an ultimate source of profit. The Thames Ironworks and the Atlas Iron and Steel Works gained their position as the acknowledged best makers of hammered and rolled armour plates respectively only after numerous failures and a heavy outlay. The Millwall Company profiting by the experience of others, made public since armour-plate forging first began, may attain a position in the first rank without such great losses. The Millwall plates were forged under the hammer, while Mr. Brown's plates were rolled. The last two years' experience, and more especially that of the past twelvemonth, has, however, proved that tougher and more perfect armour-plates can be made with the rollers than with the steam hammer. Of this fact the trade generally seem to be fully aware. The Sheffield Atlas Works now roll plates up to 7½ in. in thickness, and can make them of any required length or breadth. At the same works there is also being erected rolling machinery that will turn out plates 12in. in thickness, and still thicker if required. The Millwall Company are also erecting rolling machinery for 12in. plates.

French Ordnance.—A gun entirely built of steel, and composed of several tubes of that metal, put together in the method introduced in France by Colonel Treuillee de Beaulieu, but better known in England as "Blakeley's" plan, and which secures the simultaneous action of all the tubes in resisting the bursting force of the powder, has been recently tried in that country. The gun weighs only 4¾ tons and a few pounds, or nearly 3 tons less than the Armstrong rifled or the Whitworth plan. The French gun is rifled with three grooves, less than a quarter of an inch deep. The twist of the rifling is uniform, one turn in 30 calibres, being a slightly quicker turn than that used by Armstrong, and a little slower than that used by Cavalli and Whitworth. The gun, when last heard of, had been fired 800 times without injury. The shell weighs 45 kilogrammes, or between 99lb. and 100lb. The service charge of powder is 12½ kilogrammes, or about 28lb., although in some cases 15 kilogrammes, or 33lb. of powder, were used.

STEAM SHIPPING.

New Steam Tug "Columbus."—Messrs. Laird Bros., of Birkenhead, have just completed a new steam tug, called the *Columbus*, fitted with a pair of their disconnecting diagonal engines, 90 horse power, nominal. Speed being now a great object with tug-boats, as with all other ships, the *Columbus* was built to combine great speed with first-rate towing qualities, and on her first trial in smooth water she attained a speed of 14 knots, her engines indicating 7½ times the nominal or 650 effective horse power. On her final trial she run to Holyhead and back. She accomplished the run, although she had considerable sea and wind to contend against, at an average rate of 12½ knots per hour, with a moderate consumption of fuel.

Iron Shipbuilding in Liverpool.—Owing to the unprecedented demand for iron ships, and the high reputation Liverpool has attained for building iron sailing vessels, the yards during the past year have been in greater activity than was ever known before. This demand is attributable to the fact that iron ships can now be built at considerably less cost than wooden ones, and are in point of durability superior. The formation

of an underwriter's association, at Liverpool, to class iron vessels on their merits for periods varying up to 22 years, has had the effect of causing Lloyd's to alter their rules, which had hitherto militated against progress in iron shipbuilding. At a rough estimate the tonnage of iron vessels built, in Liverpool, during 1862, may be set down at 20,000 tons, and the tonnage of wooden ones at 6000. This, however, is exclusive of the vessels built by Messrs. Laird, of Birkenhead, whose operations have been very extensive, as may be judged from the fact, that they have, at present, orders on hand to the extent of between 18,000 and 19,000.

LAUNCHES OF STEAMERS.

LAUNCH OF THE "PAULET."—Messrs. C. Mitchell and Co. launched from their building yard at Low Walker, on the 10th ult., a large screw steamer for the service of the Intercolonial Royal Mail Steam Packet Company, and destined to carry mails between Australia and New Zealand. The vessel is named the *Paulet*, and is of the following dimensions:—Length, 228ft.; breadth of beam, 38ft.; depth of hold, 16ft. 6in. As ventilation is the chief element of comfort in a steamer built to carry passengers, this object in construction has been specially kept in view in the *Paulet*. She is not only provided with a lofty saloon, numerous skylights and side-ports, but a separate steam engine is to be erected for the purpose of thoroughly ventilating the holds, cabins, and engine-room; and so completely will the system be carried out that each private cabin will be provided with a ventilating tube. The machinery for the *Paulet* is of 150-horse power, and has been manufactured by Messrs. R. Morrison and Co. of Newcastle. Economy in consumption of fuel has been carefully kept in view, the engines being furnished with surface condensers and other fuel-saving appliances. The *Paulet* will proceed under steam to Australia, and will form a valuable addition to the Intercolonial Company's fleet.

LAUNCH OF THE IRON SCREW STEAM SHIP "TAMAR."—Another important addition was made on the 6th ult., to the Royal navy by the launch of the iron screw steam vessel *Tamar*, of 2811 tons, and 500 horse power, from the premises of the builders, Messrs. Samuda, Poplar. The *Tamar* will be fitted with her screw machinery and engines, by Messrs. Raveuhill, Salkeld, and Co. The *Tamar* was laid down in November, 1861, and is in every respect a fine specimen of modern naval architecture. She is a smart looking craft, and well adapted for speed. The following are her principal dimensions:—Length 300ft.; breadth, 44ft. 7in.; depth in hold, 34ft.; burden in tons, 2811, 82-94, old measurement. After receiving her machinery she will be removed to Woolwich dockyard to be rigged, and fitted with her armament, consisting of four rifled guns, and she is expected to be ready for service by April next.

LAUNCH OF THE "STAR OF THE SOUTH."—On the morning of the 24th ult. this iron screw steamer, built for Messrs. Broomfield and Whittaker, of Sydney, and intended for the coal and coasting trade of Australia, was launched from the yard of Messrs. Wigham, Richardson and Co. Low Walker. Her dimensions are as follows:—Length 130ft.; breadth 21ft. 6in.; depth, 9ft. 6in.; and to carry 200 tons of coal. She will be propelled by direct acting engines, by Messrs. R. and W. Hawthorn, of Newcastle, 45-horse power. After the launch the vessel was towed to Newcastle, when her machinery was fitted, and in the afternoon she returned to her builders' yard under her own steam in the short space of ten hours from leaving her ways.

THE "PRINCESS ALEXANDRA," iron paddle steamship, was launched on the 20th ult. from the yard of the Thames Ironworks, Blackwall. The *Princess Alexandra* is about 500 tons, and has been built for the service of the Trinity House, Dublin. She will be engined by Messrs. Penn.

TELEGRAPHIC ENGINEERING.

TELEGRAPHIC CABLE FOR THE PERSIAN GULF. The Indian Council have decided on a submarine cable across the Persian Gulf. They have not given over this undertaking to any company, contractor, or concessionaire. The whole management of this national work is entrusted to one of their own officers, Colonel Stewart, R.E. The core will be gutta percha, made at the Gutta Percha Company's Works, Wharf-road, London. It will be tested by Reid's process of pressure, equal to the depth of the sea where the cable is to be laid. Mr. Henley, of North Woolwich, will make the iron sheathing, and our own Government ships will submerge it. From the specimen already constructed, it is admitted to be the best submarine cable yet made, and there is no doubt it will prove so. The whole will cost about £300,000.

TELEGRAPH EXTENSION IN NEW SOUTH WALES.—The Colonial Parliament has agreed to the following telegraphic extensions during the current year:—From Deniliquin to Hay, a length of 80 miles; from Wellington to Dubbo, 35 miles; from Braidwood and Queanbeyan, 35 miles; and also an additional wire on the posts between Sydney and Newcastle. The telegraph to Kiama, which passes through Campbeltown and Wollongong, was opened on the 16th of October, with the usual congratulatory message from the Minister for Works. Kiama is conveniently situated on the coast for the observation of vessels coming towards Sydney from the southward, and the station-master is instructed to report to the telegraph office in Sydney, for public information, the names of vessels passing sufficiently near to the port to be distinguished. The telegraph to Furbes (the Lachlan diggings), on the extension from Orange to Wagga Wagga, was opened in November. The line will next be carried on to Burrangong. The extension from Tenterfield to Grafton, a length of 123 miles, was finished in November last.

TYPO-TELEGRAPH.—An extensive series of experiments are being made in France with the Typo-Telegraph, invented by M. Bonelli, by which 500 despatches of 25 words each, can be printed within an hour. Should the experiments prove satisfactory, it is intended to introduce this telegraph on the principal railway lines in France.

SUBMARINE CABLE BETWEEN SARDINIA AND SICILY.—A submarine cable has been most successfully laid between the port of Cagliari, in the island of Sardinia, and Napani, in Sicily, a length of 200 miles.

RAILWAYS.

THE METROPOLITAN RAILWAY,—The Metropolitan Railway was opened on the 10th ult., to the public, and trains continued running from six o'clock in the morning till a late hour at night. There was a great wish on the part of the public to make trial of this novel mode of metropolitan intercommunication, and small was the chance of obtaining a seat in the carriages anywhere but at the Paddington station. This was in the early part of the day, for the traffic all set in City ward; the few who had the wish to proceed westward finding ample accomodation and comfort in their experimental trip. It was soon found that the engines and rolling stock of the company were not sufficient to accomodate the crowds of passengers; and a loan of both engines and carriages was obtained from the Great Western; but even these did little to mitigate the evil, as, indeed, the addition of any number of trains to those provided by the company was attended with some danger. So great had the pressure become that about midday it was announced to the crowds collected at the different stations that their chance of proceeding down the line was hopeless, as there was then collected at the Paddington terminus passengers enough to fill the next four or five trains. In the afternoon the tide turned, the flow of passengers proceeding westward; and then the pressure became as great at the Victoria terminus at the east end. Some discouragement arose from the accumulations of smoke and steam in the long tunnel, which appeared, contrary to the sanguine anticipations of the engineers that there would be neither smoke nor steam from their engines. The annoyance was still greater on the following day, and even rose at one time to a serious height, as many of the passengers complained of headaches, and there was hardly a guard, pointsman, or station master who did not suffer from the foul atmosphere, and were obliged to be led in some instances into the fresh air.

EXTENSION OF THE METROPOLITAN RAILWAY.—This Company propose to take Parliamentary powers to purchase additional lands for the purpose of their undertaking, and for enlarging their powers of compulsory purchase of property in respect of the incomplete portion of their western extension in the parish of Paddington, near the junction of South Wharf-road with Praed-street, to the southern end of Eastbourne-terrace, where it forms a junction with Conduit-street, and also as to the incomplete portions, comprising the line to the intended Metropolitan Meat and Poultry Market, and the Finsbury-circus extension. The particular lands and properties supposed to be taken are in the parish of St. Giles Without Criplegate, near or between the streets called Little-Moorfields, New Union-street, Moor-lane, and Tenter-street; and between Whitecross-street, Milton-street, and Moor-lane, on both sides of the extension to Finsbury Railway, and between Vine-court and Maidenhead-court, adjacent to Moor-lane. The lands and buildings proposed to be taken in the parish of St. Sepulchre and Liberty of Glasshouse-yard, are in and near Cow-cross-street and Sharp's-alley, Charterhouse-lane and Charterhouse-square, and northwards of the limits of deviation defined by the Finsbury-circus Extension Act. Those at Paddington are in, near, and between Conduit-street, Spring-street, London-street, and Conduit-place.

METROPOLITAN, KNIGHTSBRIDGE, AND KENSINGTON JUNCTION RAILWAY.—It is proposed that this extension of the Metropolitan Railway shall run out of it where it crosses London-street, Paddington, and termiuate near the western bank of the Serpentine, north-west of the bridge between Hyde-park and Kensington-gardens, with branches from the termination of the latter line to a point in Hyde-park abutting on the Knightsbridge-road, westward of the lodge at the entrance to Hyde-park corner, together with a further extension to near the junction between Young-street to High-street, Kensington at an estimated cost of £600,000.

METROPOLITAN, TOTTENHAM, AND HAMPSTEAD RAILWAY.—This extension of the Metropolitan Railway is intended to start from near the eastern end of their Gower-street station, in the Euston-road, St. Pancras, and terminate on the South side of Swain's lane, at a point east of the Highgate-road. It is estimated to cost £400,000.

BARNES, HAMMERSMITH, AND KENSINGTON RAILWAY.—The route of this new line will commence at Barnes, near the curve of the Richmond and Windsor line, and run through Hammersmith and Kensington, terminating on the West London Extension-railway, about 440 yards south-east of the point where that railway passes under the Hammersmith-road. The next branch will start from Kensington Hall and terminate at Earl's Court-road, and other branches will run to the Victoria-road, Kensington, to the loop line carrying the Kew and Hounslow line over the Thames from Barnes, and from the south-west extremity of York-place to a junction with the Hammersmith and City terminus at Hammersmith. The capital estimated to be required for the line is £340,000.

AGREEMENTS BETWEEN THE GREAT WESTERN RAILWAY AND THE SOUTH WESTERN, AND NORTH WESTERN COMPANIES.—A circular has been issued by the Great Western Railway Directors, informing the shareholders "that in conjunction with the West Midland Company, they have entered into two separate agreements; the one with the London and South Western Railway Company, and the other with the London and North Western Railway Company. The main object of these agreements is to utilise existing lines by increased facilities being given to each other, thereby affording improved accommodation to the public, and avoiding expenditure by the projecting of new lines, which might tend to unnecessary or injurious competition. The agreements for amalgamation of the West Midland and South Wales Companies with the Great Western are presented, for confirmation by Parliament, in the approaching Session. The only bill for a new work promoted in this Session by the Great Western Company is to complete a short junction at Great-bride, in South Staffordshire, between two lines already formed, and for which provision is made under an agreement with the London and North Western. The directors add that they have thought it desirable to place these facts before the shareholders, and that they will be prepared, when they meet the proprietors in February, to afford a full explanation of these matters.

DOVER, DEAL, AND SANDWICH RAILWAY.—The route of this new line will be by a junction from the Shepherdswell station of the London, Chatham, and Dover, to Albert-terrace, Deal; then from the latter line between Eastry and Ham to the the South Eastern Railway at Sandwich, near the Sandwich Gas Works, at an estimated cost of £100,000.

GREAT EASTERN RAILWAY.—This company is about to place ten additional passenger and thirty additional goods engines upon its railways, at a cost of £100,000. The intended acceleration of the train service has been posponed for the present.

CHARING-CROSS AND SOUTH-EASTERN RAILWAYS.—It is proposed to amalgamate the Charing-Cross and South-Eastern Railways, on such terms and considerations as the two companies may think fit, subject to the terms and considerations being sanctioned by three-fifths of the votes of the shareholders in each company. The agreement is to take effect either before or after the completion of the works of the Charing-Cross line, which are now in course of construction.

NORTHERN OF FRANCE RAILWAY.—The traffic receipts on the old lines of this company during the year 1862 amounted, on 631 miles, to £2,630,100, and for the year 1861, on 605 miles, to £2,582,757, showing an increase of £37,403, or, 1·41 per cent. The total receipts on 68 miles of new line amounted, for the year 1862 to £107,953, and for the preceding year to £20,588, showing an increase of £87,365.

SOUTH AUSTRIAN AND LOMBARDO-VENETIAN RAILWAY.—The total traffic receipts on the South Austrian line, 1004 miles in length, amounted for the year 1862 to £2,264,038, and for the year 1861 to £2,260,486, showing an increase of £3,552. The total traffic receipts on the Lombardo-Venetian line, 216 miles in length, for the year 1862, amounted to £334,465, and for the year 1861, on 199 miles, to £262,625, showing an increase of £71,840. The total receipts on the two lines last year amounted to £2,598,503, and for the preceeding year to £2,523,111, showing an increase of £75,392, or about 3 per cent. The traffic receipts on the Central of Italy branch, 91 miles in length, amounted for the past year to £186,719, and for the preceeding year to £148,460, showing an increase of £38,259, or 25·8 per cent.

RAILWAY TO CONSTANTINOPLE.—A project has been set on foot by an engineer named Dumont, to continue the present continental railway communication as far as, Constantinople. The present European network of railways extend as far as Bazias, a small port on the Danube, 650 kilometres (⅝ of a mile each) distant below Pesth. The line from Paris to Bazias by Strasburg, Munich, Vienna, and Pesth is about 2100 kilometres in length, and the journey may be performed in sixty hours. This line of railway might be extended to the Black Sea and Constantinople in two directions; one by Belgrade, Servia, Bulgaria, and Roumelia, a line already surveyed by the English; and the other which would reach Constantinople by Roumania, passing by Crajova, Bucharest, Rustchuck, Schumla and Adrianople, crossing the Balkans at the most available point, in the neighbourhood of Aidos. This is Dumont's project. The total length of the proposed lines will be about 1500 kilometres, thus divided:—On the Austrian territory, from Bazias to the frontier of Roumania, near Orsova, 125 kilometres; from Orsova to Rutschuck by Bucharest, 351 kilometres; from Rutschuck to Constantinople by Schumla, Aidos, and Adrianople, 609 kilometres; giving a total from Orsova to Constantinople of 1,085 kilometres. Branches from Bucharest to Bazias and Galatz, and those from Cernavado to the foot of the Carpathians, would be altogether about 400 kilometres, making a total length of 1,485 kilometres.

Works in Melbourne.—The great trunk line as far as Castlemaine and Sandhurst has been opened for traffic, but is not yet completed. It was opened a certain distance in April last, so that the portion opened is about fifty-seven additional miles. In this space some of the greatest engineering difficulties have been met with—two tunnels, each nearly a quarter of a mile long, besides several fine viaducts. Although the whole of the works have been executed in the most substantial manner, yet it does seem that some at least of the gradients need not have been so steep; Sandhurst being situate beyond the dividing range that had to be crossed; and this is done at an altitude of 1950ft., within a distance of 45 miles of the sea level. One viaduct is of five spans, 130ft. each, and 120ft. high. This is over the valley of the Black Creek. That over the Coliban consists of five arches, each 60ft. span, and 70ft. high.

Railroads in Chile.—On the 3rd November last the third division of the Southern Railway of Chile was opened to San Fernando, the capital of the province of Colchagua, distant from Santiago 86 miles. The length of this extension is 34 miles, and the works have been designed and finished in a style alike creditable to engineer and contractor. The first passenger engine over the new works took down the President of the Board, the directors, and a large party of friends, who returned to Santiago much pleased with the day's trip. The general character of the earthworks is light, but there are several bridges of importance, and a very considerable number of small openings and culverts. The bridges are executed in a simple but solid manner, and are good examples of work. The girders were made in England, and the masonry is principally native labour, and is cut from a white or pink porphyry which is very abundant in the country The Engineer-in-Chief, Mr. W. Cross Buchanan, was a pupil of Mr Neil Robson, of Glasgow; and the gentleman who undertook and finished the contract is an American, well known on the coast for his activity and energy. He is also engaged on another contract, namely that of the Santiago and Valparaiso Railway, the works of which are being rapidly pushed on. The charter of the Southern Railway Company of Chile empowers them to carry on their line as far as the river Maule, and this, as well as a much further extension, is at present under consideration in the Camaras. In all probability the surveys will shortly be proceeded with, preparatory to contracts being entered into with an eminent English contractor, who, it is understood, has made very advantageous offers to the Chilian Government.

Portugese Railways.—Mr. Price the contractor, to whose execution the works on the South Eastern of Portugal Railway have been entrusted, has lately returned from Lisbon, and reports that he will be prepared to open 60 miles of that railway in the month of June next, and the remaining 20 miles shortly afterwards. It is stated that the works have been executed in a very superior manner, and that they give perfect satisfaction to the Portugese Government.

Traffic Returns.—The traffic receipts for railways in the United Kingdom amounted, for the week ending the 3rd of January, on 10,584 miles, to £483,396, and for the corresponding week of last year, on 10,193 miles, to £460,796, showing an increase of 391 miles, and of £22,600 in the receipts. The gross receipts on the following fourteen railways amounted, in the aggregate, on 7,268 miles, to £380,942; and for the corresponding week of 1862, on 7008 miles, to £364,713, showing an increase of 260 miles, and of £16,229 in the receipts. The increase on the Caledonian amounted to £202; on the Great Eastern to £1533; on the Great Northern to £1097; on the Great Western to £3222; on the Lancashire and Yorkshire to £139; on the London and North Western to £3319; on the London, Brighton, and South Coast to £663; on the London and South Western to £1334; on the Manchester, Sheffield, and Lincolnshire to £604; on the Midland to £3223; on the North British to £1135; on the North Eastern to £796; and on the South Eastern to £357; total, £17,624. But from this must be deducted £1395, the decrease on the Great Southern and Western, leaving the increase, as above, £16,229. The goods and mineral traffic on those lines amounted to £195,102, and for the corresponding week of 1862 to £187,237, showing an increase of £7963. The receipts for passengers, parcels, &c., amounted to £185,740, against £177,476, showing an increase of £8264. The traffic receipts on sixty-four other lines amounted, on 3316 miles, to £102,454; and for the corresponding week of last year, on 3185 miles, to £96,083, showing an increase of 131 miles, and of £6371 in the receipts. The total receipts of the past week show a decrease of £47,314, as compared with those of the preceding week, ending December 27.

RAILWAY ACCIDENTS.

Sinking of a Railway Viaduct at Clapham.—On the morning before the new year, an occurrence of a serious nature, though unattended with loss of life or bodily injury, took place near the Clapham station of the Metropolitan Extension of the London, Chatham, and Dover Railway. That part of the Metropolitan Extension Railway, which is to join the Victoria Station at Pimlico by a bridge across the Thames at Blackfriars with the Farringdon-street terminus, was opened some time back, from Victoria to the Elephant and Castle. The second station on the line is that at Clapham, and at about 200 yards distant the line crosses the Clapham-road and the Bedford-road by means of iron girder bridges. Between these two bridges is a viaduct consisting of nine arches of massive brickwork standing in a field. All the structure appeared to be quite safe up to the evening before the accident, when there were slight indications in the parapet of a subsidence of one of the centre piers taking place. The officials of the company were at once apprised of the fact, and every precaution was taken for the safety of the public by watching, &c. About half-past six the following morning, the men on watch found that the pier began to sink rapidly, and before long it had subsided upwards of four feet into the earth, carrying with it the next pier, and, as a matter of course, the centre arch and portions of the arches on each side. Notwithstanding this great sinking and the manner in which a large portion of the brickwork had become broken up, the rails did not give way for some time. Information was at once sent up to the Victoria terminus, as a train was to leave at 7.25, and the working beyond Clapham was stopped. Almost immediately a large body of workmen were on the spot, and the traffic between the Clapham and Brixton stations having been suspended, steps were taken to shore up the arches on both sides of those damaged.

Accident on the Great Northern Railway.—About half-past eight o'clock on the morning of the 6th ult. an accident occurred near the railway station at Knottingley. At a distance of about 200 yards from the Knottingley station there is a junction of two lines of rails, one of them being from York and the other from Leeds. Parliamentary trains leave York and Leeds for London every morning, arriving at the Knottingley station, where they form one train, at half-past eight o'clock. Up to about ten minutes past eight on the morning of the accident the weather was fine and clear, but at that time it became suddenly foggy, and, at half-past eight o'clock, the time at which the trains were due, the fog was so dense that it was impossible to see more than a few yards. It was at that time that the accident happened. At about 130 or 140 yards from the station there is a bridge spanning the rails, and immediately beyond this there is a pointsman's and signalman's box. The junction of the lines referred to is some thirty or forty yards beyond, and at some distance down the lines there are signals by which the drivers of the trains are informed whether they can with safety approach the station. The two lines of rails are joined into one at the distance of a few yards from the pointsman's box, and it was just at the junction where the accident occurred. As was perfectly regular, the Leeds train proceeded towards the station first, and in the usual course the York train would have been signalled to approach when the line was clear, but unfortunately it ran forward before its time, became entangled with the Leeds train, and caused serious mischief. Neither of the trains was moving very rapidly at the time, or the consequences would have been most disastrous. As it was, when the carriages came into collision two or three of them were thrown off the line, and two of them were turned over and smashed. One of these carriages was empty, but several of the occupants of the other were very seriously injured.

Railway Collision near Liverpool.—A collision took place on the London and North-Western Railway, near Liverpool, between a passenger train and a goods train, on the 5th ult. Several persons sustained injuries; the severe concussion of the trains also causing considerable damage to the engines attached. The 12·30 (midnight) passenger train from Liverpool to Warrington had got so far as Whiston Bank, where there is an incline of about a mile in length at a gradient of about 1 in 80, and up which heavy trains have to be assisted by a bank-engine. When the train had arrived near the top of the incline the driver observed that he was dashing on to the bank-engine, which was in the act of pushing up a goods train. He immediately reversed his engine and endeavoured to stop, but could not do so in time to prevent the collision, which took place with great force. The passenger-engine's buffers were smashed to pieces, the buffer-plank and the iron framing of the engine were broken, and the tender of the bank-engine likewise very much damaged.

BRIDGES.

Opening of Lendal Bridge, York.—The opening of this iron bridge which has been erected over the river Ouse at Lendal, York, recently took place. The foundation stone of a bridge was laid on the 9th of October, 1860. As the bridge advanced, and its character became more prominently displayed, neither those who had seen the plans nor the general public were at all satisfied with the appearance it was likely to present. Circumstances attending the destruction of the bridge on Friday, Sept. 27th, 1861, very nearly a year after the foundation stone had been laid, will be in the recollection of many of our readers. One of the girders fell into the river, and the others were prostrated upon the bridge, five persons employed thereon being instantly hurried into eternity. The design for the bridge (which is after the style of the Westminster Bridge) presented by Mr. Page was ultimately adopted, and the contract for the iron work from Messrs. Hawks, Crawshay, and Co., of Gateshead, for £3600, was accepted by the committee. The bridge consists of a single arch of the Tudor style, has a span of 175ft. 2in., and is 25ft. in height from the summit level of the river to the crown. Six ribs of immense size are tied together with cross girders and braces tied and stayed, there being bearers for the corrugated iron plates which had been prepared for the girder bridge and which have been used up in the present bridge. The spandrils consist of castings of Gothic tracery ornamented with large shields of the city on one side, and the arms of the see of York on the other. The footpaths on the bridge are formed of the Hopton Ward stone, a beautifully white paving stone, which has been used at the Houses of Parliament. The extreme width of the bridge is 37ft. 9in.; the width of the footpaths, 8ft. 3in.; and the width of the roadway, 21ft. 3in. The weight of the bridge is at least 330 tons, and it is believed to be of sufficient strength to carry a railway train.

Westminster Bridge.—From a Parliamentary return just issued it appears that up to the 14th of last July a sum of £393,189 19*s*. 2*d*. was expended on Westminster Bridge. Of this amount, £145,057 18*s*. 5*d*. was paid to contractors, and £248,132 9*d*. to other parties. The amount expended on the approaches was £109,054 4*s*. 9*d*. The whole of the outlay has been supplied from property belonging to the Westminster Bridge Commissioners, and from votes of Parliament.

DOCKS, HARBOURS, &c.

The Metropolitan Board of Works have, by a majority of thirty-three votes to one, have resolved that the resolution of 1858, for erecting deodorising works at Fulham, should be rescinded. The engineer is to report on the best way of conveying the sewage of the western area into the northern low-level sewer. The Thames will thus be freed from one cause of impurity with which it was threatened.

The Great Iron Floating Dock built at Sourabaya, Java, from the designs of Mr. R. W. Thompson, C.E., has been successfully launched. The difficulties of launching such an immense structure were evaded by building it in a kind of dam made on the seashore. When the iron dock was completed the sea wall of the dam was broken, and the sea rushed in lifting the dock from the blocks on which it had been built. Messrs. Randolph, Elder & Co., of Glasgow, have lately completed a similar iron floating dock for the French Government. This structure is capable of lifting out of the water the largest man-of-war in the world, not excepting the *Warrior*, with all her guns and armour-plates in their places. This dock is also from the designs of Mr. Thompson.

GAS SUPPLY.

Gas at Aldershot Camp.—A portion of the permanent barracks at Aldershott have been lighted with gas from extensive works erected by the government on the banks of the Basingstoke canal. The gas supplied is said to be pure and good, and its introduction is regarded with much satisfaction by all ranks and branches of the service. The Gas-works, it is stated, were erected at a cost of £22,000.

The Worcester Gas Company's directors have announced a further reduction in the price of their gas, from 5*s* to 4*s*. 6*d*. per 1000 cubic feet.

BOILER EXPLOSIONS.

Manchester Association for the Prevention of Steam Boiler Explosions.—At the ordinary Monthly Meeting of this Association, held on January 6th, 1863, the chief engineer presented his Monthly Report, of which the following is an abstract:—"During the past month, ending December 31st, 1862, there have been examined 430 engines—3 specially; 621 boilers—12 specially, 9 internally, 54 thoroughly, and 546 externally, in which the following defects have been found:—Fracture, 4; corrosion, 33 (1 dangerous); safety valves out of order, 13 (2 dangerous); water guages ditto, 24; pressure guages ditto, 9; feed apparatus ditto, 1; blow-off cocks ditto, 32 (1 dangerous) furnaces out of shape, 7 (2 dangerous); blistered plates, 1. Total, 124 (6 dangerous). Boilers without glass water guages, 6; without pressure guages, 16; without blow-off cocks, 27; without back pressure valves, 44. While I am happy to be able to report that no explosion has happened during the past month to any of the boilers under the inspection of this Association, the occurrence of five explosions in other quarters during that period has come to my knowledge. Each of these has been attended with fatal consequences, twenty-six persons in all having been killed, and upwards of thirty-two injured. Two of the exploded boilers were personally examined. The first of these explosions, and from which ten persons were killed and twenty-six injured, occurred at an iron works. The boiler was a horizontal one, of plain Cornish type, with a single internal flue, and a longitudinal steam chamber fixed above the shell. It was heated, as is common in such works, by the flames passing off from the iron furnaces, the flames of one of these passed through the internal flue in one direction, and those from two others passed outside the shell in the other direction. These furnaces were placed immediately at the ends of the boiler, one at one end and two at the other. The dimensions of the boiler were as follows:—Length, 25 feet; diameter of the shell, 5ft. 3in.; of the internal flue tube, 2ft. 3in.; thickness of the plates, three-eighths throughout, with the exception of the flat ends, which were half inch, and strengthened with gussets in the ordinary way. The wreck was so complete that sc [illegible] a trace of the fittings remained; but they are reported to have consisted of two s fety valves two and a half inches n

diameter, a float and glass water guage; which latter, however, had been broken a short time previous to the explosion; while there remained on the ground the feed back pressure valve and the feed stop tap. The load on the safety valve was stated to have been 70 pounds on the square inch; but the boiler had not been fitted either with a steam pressure guage or with a tap for applying the indicator, so that no means had existed of checking the actual pressure when the steam was up. The rents in the boiler, as well as the flight of the parts consequent on explosion, were extremely complicated, and are difficult clearly to describe. Generally, it may be stated that the shell and internal flue tube had been completely torn asunder one from the other, and that each of the end plates, gusset stays and all, had been wrenched from both shell and tube. To go more into detail. The shell had been rent transversely into two parts, and the longitudinal steam chamber dismantled. The internal flue tube had collapsed and separated into four lengths, fracturing at the ring seams of rivets. The longitudinal seams which were at the sides of the tube ran in line from one end of it to the other, and the collapse which is usually vertical, was in this case lateral, and had brought these longitudinal seams from each side of the tube close together. This was the case in each segment of this disjointed tube. The end plates, which had been built in pieces, were separated at each of the seams, and disengaged from the shell and flue tube by shearing both rings of angle iron. One gusset adhered to the end plate, but in the main they were torn away from both end and shell. There were many minor fragments, which were completely curled or crumpled up. The cause of this explosion was attributed at the inquest to shortness of water, which, leading to overheating of the plates, had, it was supposed, on the re-introduction of the feed, resulted in a sudden and excessive pressure of steam. This was imputed to the carelessness of the engine tenter, and the jury found him guilty of manslaughter; in consequence of which he was committed to the next assizes for trial. There is good reason to question the correctness of the above conclusions, and to attribute the explosion to other causes than shortness of water and the negligence of the engine tenter. The pressure of seventy pounds to the inch, at which the safety valves were stated by the manager of the works to have been loaded, was excessive for a boiler of such construction; not so much so for the shell as for the internal flue tube, the latter not being half the strength of the former. This must have been the case even when the boiler was new and even if the tube was perfectly circular; but since the tube had been repaired, in consequence of overheating, and very frequently a good deal of straining occurs in replacing old plates; also, many tubes are found on actual measurement not to be truly circular, although nominally so; and had this been the case in this instance, its strength would have been considerably less than half that of the shell. In attempting to unravel the complicated rents produced in boilers on explosion, it is important to bear in mind that girder strains and leverages, the amount of which it is difficult to calculate, are induced in the plates as soon as the statical equilibrium is disturbed by the occurrence of a rent. Collapse of flue tubes has been found in other cases to break them up into short lengths at the ring seams, and to shear the end angle irons through at the roots, as was the case in this instance. Upon careful consideration of all the circumstances, to enumerate the whole of which would be tedious, there appears every reason to believe that the explosion resulted from the collapse of the flue tube consequent upon its inherent weakness, and not from shortness of water; while that collapse might have been prevented either by the introduction at the time of the construction of the boiler, of flanged seams, or hoops of T iron, angle iron, or other approved form, or else by the addition to the flue, since it was made, of angle iron hoops. "The second explosion was of a much simpler character than the one just referred to, and occasioned scarcely any damage to property. The boiler was of plain double-flued internally-fired construction, such as is in general use at cotton mills in Lancashire. Its length was 25ft. 6in.; the diameter of its shell, 7ft. 6in.; and of its internal furnace tubes, 2ft. 10in.; the thickness of the plates in both being, from three-eighths to seven-sixteenths. The fittings were complete as to number, as well as satisfactory as to condition, and all that was necessary with due care for safe working. The working pressure was stated not to have exceeded thirty-five pounds, and there was no reason to doubt the correctness of this, while the boiler was perfectly capable of working safely at a much higher pressure, as long as it was in good condition. On examining the boiler, it was at once apparent that it had not exploded either from excessive pressure or shortness of water, but from thinning of the plates through external corrosion, from which a rent occurred in the last ring of plates of the shell in the left-hand flue immediately above the brickwork on which the boiler rested, it being set on what are termed side walls. This rent extended longitudinally through the solid of the plate, throughout its whole width, from one ring seam of rivets to the other, but opened only a few inches transversely forming a slot, the edges of which were blown outwards into the form of lips. The plate at this part was reduced by corrosion to the thickness of a sheet of brown paper, and some pieces were broken off with the fingers by one of the jury as specimens. It may be added that daylight could be distinctly seen through the adjoining plate, which had not been disturbed from its original position by the explosion, but was completely eaten through by corrosion in the form of veins, so that either leakage must have been going on at this part for some time, which, however, it can scarcely be imagined could have escaped detection, or else the plate must have depended on a coating of scale, such as was to be found in other parts of the boiler, for keeping it tight. It is unusual for a longitudinal rent in a cylindrical shell to confine itself to such narrow limits as this had done, and the fact is to be attributed to the proximity of the end plate and the lowness of the working pressure. The rush of steam and water had blown up the upper part of the brickwork flue, but the boiler was not moved from its place, and no further damage to property appeared to have been done. The loss of life occasioned by the explosion resulted from scalding, the persons killed being in the boiler-room at the time. The corrosion which, as previously stated, was external, was caused by damp in the flue, the plates being most seriously affected for a considerable distance along the seating, in addition to the part actually rent. This was at once apparent upon entering the flues, where large cakes of oxide were readily collected. Competent inspection could not have failed to have detected the corrosion and prevented the explosion The flues were stated to have been swept out about once a year only, whereas this should be done at least every three months, not only to prevent the loss of fuel that must result from an accumulation of soot, but also in order to afford an opportunity of examining the condition of the plates."

MINES, METALLURGY, &c.

COAL AND IRON WORKS IN RUSSIA.—Within the last two months a number of men have left the Dawlais and Rhymac Ironworks for Russia. A gentleman connected with the Government of that country, came over and selected some of the best workmen connected with these works, and the wages agreed to be paid them were from £12, to £20, per month, being double and treble the money they earned in Wales. It appears that large ironworks are about to be started in Russia, and, as metallurgy and iron-making are comparatively unknown, the far-seeing Muscovites no doubt thought it would be well to have some practical men from this country. One of the party is expected to return shortly, it having been determined to secure the services of a few Welsh colliers as well.

THE COPPER MINES OF SOUTH AUSTRALIA.—The Moonta Mine has declared a dividend amounting to £32,000, or £10, per share. A second similar dividend it is expected, will be declared in January. The Burra Mine has also paid another dividend of £5, on the original £5 shares, being the 50th dividend of 100 per cent, that has now been paid out of that mine. The first work on a practical scale for reducing ores by Rodda's patent process have been completed at the New Cornwall Mine, and a company is in process of formation for erecting more extensive works at other mines.

ON THE QUICKSILVER MINES OF CALIFORNIA, BY DR. L. FEUCHTWANGER.—Among the inexaustable resources of California, quicksilver is one of the most interesting and profitable, for the simple reason, that the cost of mining and extracting the metal from its ore, the cinnabar, is the least expensive of all the valuable and costly ores, such as gold, silver, and copper. The yield of quicksilver is from 70 per cent. down to 25 per cent., and the mode of separation is very simple. The new Almaden mine has sixteen furnaces, containing 20,000lbs. of the cinnabar, and two larger ones, containing 90,000lbs. of the ore, and producing daily 100 flasks of 75lbs. of quicksilver each. Having visited many localities in the month of May, 1862, I feel satisfied that quicksilver will, ere long, form an important item of export to every part of the world, for the steamer on which I left San Francisco had a considerable number of flasks for China, Mexico, and England; and with the increased demand in the Washoe district for the extraction of silver, the new gold placers of Victoria and Cariboo, and all the other cinnabar mines of the Sonama and Napa valleys, will likewise be put in requisition. The new Almaden mine has long been known to the Mexicans and Indians, the cinnabar, when ground fine, being called vermilion. It was made an article of traffic by the Indians along the coast as their red paint. From them the early white settlers of California learned the locality, and a Captain Castilero, of the Mexican service, registered the lands as his property, and formed a company for the purpose of extracting the quicksilver. Messrs. Bolton and Barrou now hold the Castillero title, and an injunction which had been laid upon the mine for several years has been removed this year, and the mine is now their rightful property. From the magnitude of the mine, as well as of the smelting works, and the proper manner of operating, I feel satisfied that a more prolific mine does not exist anywhere. Along the range of these mountains, only three miles distant, is another quicksilver mine, called the Guadaloupe, which yielded considerable quantities a year ago; and the new Price and Enriquets mines, belonging to the same range of mountains, yielded 14,007 flasks of quicksilver in 1860. A very rich and extensive deposit of cinnabar, called the Aurora quicksilver mine, occurs in the quartz of Monterey. In Sonama county, in the vicinity of Mount St. Helena, near the famous Geyser Springs, a range of mountains, about ten miles in length, is found quicksilver ore in great abundance. The Pioneer mine is nearest the Geysers, and the pure metal may be detected everywhere running out from the rocks. Next comes the Pacific mine, which has likewise fair prospects for a solid and regular vein of the cinnabar. The Denver mine and the Dead-Broke mines have also the strongest indications of regular veins. In Knight's Valley, in Sonoma county, in Santa Clara country, in El Dorado county, are also found indications of regular mines; and in Mariposa county, at Phillips' Ferry, near the Stanislaus river, in the Mono diggings, a lead of cinnabar, thirty feet in width and seven miles long, has been discovered. At the Rogue and Klamatts rivers rich leads of quicksilver have also been discovered.

APPLIED CHEMISTRY.

HYDROGEN GAS.—Mr. Christopher Binks, of Parliament Street, proposes to obtain hydrogen gas by the decomposition of steam, such steam being passed through wood, charcoal, coal, or coke. It has hitherto been usual to heat the wood, charcoal, coal, or coke, and then pass the steam at the ordinary temperature through them, but as an improvement upon this, Mr. Binks proposes to superheat the steam, and keep it at a high temperature while it is passed through the wood, charcoal, coal, or coke, at an ordinary temperature, the result being that the hydrogen is more cheaply and readily produced.

ON THE FORMATION OF ACETYLIDE OF COPPER IN COPPER TUBES FOR CONVEYING LIGHTING GAS, BY M. CROVA.—It is well known, that copper tubes, long used to conduct lighting gas, have sometimes, during the cleansing of the interior, occasioned very dangerous and sudden explosions, occasionally proving fatal to the workmen. In one of the scientific reviews, an accident of this kind is recorded as happening at Philadelphia. Acetylide of copper having the property of detonating by an elevation of the temperature or by a blow, and the presence of acetylene in lighting gas having been recently proved by M. Berthelot, I have tried to ascertain whether acetylene, in presence of air, could combine with copper, and so form acetylide of copper. By passing a mixture of air and moist acetylene through a glass tube containing bright copper turnings, this metal tarnishes rapidly, assumes iridescent colours, and finally becomes black, but as this alteration takes place only on the surface of the metal, it is very limited. By using copper reduced by hydrogen, I extended the surface of the metal. A small quantity of metal was placed in two flasks containing a mixture of equal volumes of air and acetylene, and also in one of the flasks a drop of ammonia. The two flasks, well stoppered, their necks plunged in water, were left to themselves for two days, They were then carefully opened, and the water entering them absorbed nearly half the gaseous volume. The absorption seemed to be somewhat greater in the flask containing a little ammoniacal vapour. The copper turned black. After washing and drying, I found that it contained a notable quantity of acetylide of copper; for, heated with hydrochloric acid is disengaged acetylene, and thrown on a heated metallic plate, a louder explosion resulted than with pure acetylide, and without deposit of carbon. This difference will be readily understood, for the acetylide formed during my experiments, finding itself in presence of excess of oxide of copper, the carbon and hydrogen of the acetylide were entirely destroyed. It is evident that copper, in presence of air and acetylene, is spontaneously transformed into acetylide of copper containing excess of oxide. As lighting gas contains acetyline, a little air, and perhaps even some ammonical vapours, it is obvious that acetylide of copper may be formed in tubes which have served to conduct lighting gas.

ON THE PROMPT ESTIMATION OF THE SOLUBLE SULPHIDES CONTAINED IN CRUDE SODAS, BY M. H. LESTELLE.—Soluble sulphides, the formation of which in the manufacture of artificial soda cannot be entirely prevented, are of great importance when viewed in connection with the commercial value of this product. It is important, also, in the course of the manufacture, to determine frequently the relative proportions of sulphides contained in crude sodas. These estimations can be made rapidly and exactly by the following method, based on the insolubility of sulphide of silver, and the solubility of all the other argentiferous salts, in presence of ammonia. Prepare a normal liquid of ammoniacal nitrate of silver by dissolving 27·690 grammes of fine silver in pure nitric acid, adding 250 cube centimètres of ammonia, and diluting with water to bring the volume to 1 litre. Each cubic centimètre of this solution corresponds to 0·010 gramme of monosulphide of sodium. Then dissolve in water the substance to be analysed add ammonia, boil, and then add, drop by drop, by means of a burette divided into tenths of a cubic centimètre, the ammoniacal silver liquid, and a black precipitate of sulphide of silver takes place. When nearly all the sulphur is precipitated, filter, and into the filtered liquid pour a fresh quantity of silver solution, until, after repeated filtrations, a drop of this liquid produces only a slight opacity. The estimation is then at an end, and it is only necessary to read the divisions indicated by the burette, and to compare this number with that of the weight. To estimate very small quantities of sulphide, the argentiferous liquid must be more diluted, and so that each cubic centimètre corresponds to 0·005 gramme of sulphide. By this rapid method, which at most requires five minutes, I have estimated the amount of sulphides contained in the washings of soda and of artificial soda. By these means I have ascertained that the best sodas always contain from 0·10 to 0·15 per cent. of sulphide; while those submitted for too long a time to the action of fire, distinguished as *burnt sodas,* contain a proportion rising to 4, 5, and even 6 per cent. Such variations affect the qualities of sodas, and, consequently, the washings destined for the manufacture of salts of soda. It is, then, necessary to make these estimations as frequently as possible. Moreover, the presence of chloride of sodium, sulphate, carbonate of soda, caustic soda, &c., makes no difference in the exactness, by reason of the solubility in ammonia of the precipitates given by these bodies with nitrate of silver.

LIST OF APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF, "THE ARTIZAN."

DATED DECEMBER 24th, 1862.

3430 T. C Hiude—Generating carbonic oxide.
3431 S. Haslam & A. Eatough—Preparing cotton to be spun.
3432 G. H. Birkbeck—Instruments for surveying and levelling.
3433 J. Broadbent & J. Robinson—Opening and cleaning cotton.
3434 F. N. Gisborne—Indicating the speed of ships at sea.
3435 A. P. Tronchon—Fire-arms.
3436 J. S Smith—Looms for weaving.
3437 W. C. Galloway—Pianofortes.
3438 W. Hendersou—Obtaining iron and steel from certain ores and residual products.
3439 W. Clark—Applying heat to the feet in boots and shoes
3440 H. Tavelvetrees—Washing machines.
3441 J. Fairless—Milking cows.
3442 R. Lakin & J. Wain—Spinning and doubling cotton.
3443 E Stevens—Making bread, biscuits, and pastry.
3444 J. Taylor—Carding cotton.
3445 J. & W. Lord—Fluting rollers.
3446 J. H. Johnson—Stamping paper.
3447 D. G. Hope—Obtaining and applying motive power.
3448 A. V. Newton—Skates.
3449 J. Platt & W. Richardson—Pulverising artificial manures and chemical salts.
3450 C. J Dentou—Revivifying animal charcoal.
3451 R. Knox—Metallic pens.

DATED DECEMBER 26th, 1862.

3452 W. Clark—Fire-arms.
3453 C. F. Varley—Electric telegraphs.
3454 E T. Loseby—Ascertaining the pressure and the moving force of the atmosphere.
3455 J. Swainson—Pill boxes.

DATED DECEMBER 27th, 1862.

3456 W. H. Samson—Cultivating land by steam power.
3457 M. F. A Coortois—Wax candles and torches.
3458 J. & S. Fremantle—Propelling vessels.
3459 J. Petrie—Slide valves for steam engines

DATED DECEMBER 29th, 1862.

3460 M. Ker—Wardrobes.
3461 J. G. Taylor—Dress fastenings.
3462 J. H. Riddell—Pipes for cooveying gases, fluids, or vapours.
3463 J. H. Riddell—Stoves.
3464 A. W. Sleigh—Making ships and batteries impenetrable.
3465 F. Tolhausen—Petroleum or coal oil as fuel.
3466 G. Haseltine—Cartridges.
3467 C E. Wilsoo—Wearing apparel for the neck.
3468 W. E. Newtou—Preserving organic substances from decay.
3469 W. Billioghurst & J. Requa—Portable battery.

DATED DECEMBER 30th, 1862.

3470 J. Johnston—Surface refrigerator.
3471 J. Robson, jun.—Fittings for stove grates.
3472 J. H. Johnson—Ingot moulds.
3473 H. A. Bonneville—Saddles.
3474 F. B. Anderson—Watches.
3475 W. & H Bowser—Protecting iron and steel.
3476 W. Mould—Plaiting and measuring fabrics.
3477 J. E. Carter—Chimney tops.
3478 W. Richards—Fire-arms.
3479 W. Clark—Governing apparatus.
3480 C. Beslay—Steam engines.

DATED DECEMBER 31st, 1862.

3481 B. Bottomley—Doubling threads of cotton.
3482 W. B. Adams—Railways and tramways.
3483 F. Applegate—Woollen cloth.
3484 J. S. Smith & J. Hardman—Power looms.
3485 J. W. F. Field—Breech-loading fire-arms.
3486 W. Clark—Arrangement of the parts of rail way trains and the application of power for their propulsion.
3487 J. M. Napier—Heating apparatus.
3488 F. Jaques—Cases for pipes and cigars.
3489 F. Loret—Doubla wett forks.
3490 W. Malthy—Extioguishing fires.

DATED JANUARY 1st, 1863.

1 R H. Collyer—Paper.
2 W. H. Brown—Battery plates.
3 G. Allcroft—Pressure and vacuum gauges.
4 M. E. Bowra & A. F. Francis—Elastic fabrics.
5 J. T. Smith—Obtaining motive power.
6 R Fankis—Traction engines.
7 J. J Southgate—Portable fire escapes.
8 J. Jones—Stiffening textile fabrics.
9 W. Soutter—Raising and planishing metals.
10 W. Robinson—Glasses for lamps.
11 J. E. Baker & J. Land n—Boots and shoes.

DATED JANUARY 2nd, 1863.

12 W. A. Distin—Pipes.
13 F. C. Bakewell—Apparatus for burning oils.
14 C. Eyland—Buckles.
15 H. Lyon—Finishing and packing cigars.
16 A. Bamford, R Blomley, R. Taylor, & J. Lett—Looms for weaving.
17 E T. Hughes—Producing designs upon velvets, cloth, furniture, and hangings.
18 W. H. Muntz—Attaching sheathing to iron and other vessels.
19 H. J. Sergeant—Dressing and finishing silk and other fabrics.
20 J. E. Dowson—Wrought metal piles, columns, and shafts.
21 R. C. Ransome—Reaping machines.
22 A. S. Bolton—Wire.

DATED JANUARY 3rd, 1863.

23 H. Jones—Steam engines
24 E. Skull & E. Mealing—Chairs.
25 W. Philippi—Bearings and axle boxes for machinery, carriages, and railway rolling stock.
26 S. White—Purifying, bleaching, and refining oils and oily and fat y matters.
27 W Astrop—Paper.
28 C. B Clough—Curing smoky chimneys.
29 W. T. Smallware & C. B. Weaver—Covering steel for making crinoline skirts.
30 W. E. Newton—Firing cannon and fire-arms.

DATED JANUARY 5th, 1863.

31 E. B. Keeling—Lighting halls and theatres.
32 H. Yates—Shovels and spades.
33 J. A. Cooper—Substitute for silk, cotton, and flax.
34 J. Howard & J Bullough—Warping machines.
35 H. Blacktin—Preserving money, papers, or other property at sea in case of shipwreck.
36 A. Monnet—Twisting and throwing silk.
37 H. Bessemer—Pressing, moulding, embossing, shaping, crushing, shearing, and cutting metallic substances.
38 H. Chamberlain—Generating and condensing steam and evaporating liquids.
39 D. Nevin & W. Coppin—Clearing and separating the woody parts from flax and hemp.

DATED JANUARY 6th, 1863.

40 J. A. Munn & J. D. Cobb—Automatic walking dolls and other figures.
41 W. E. Newton—Magneto electric telegraphs.
42 C. T. Judkins—New alloys.
43 J. Eckersley—Spinning silk, cutting pile fabrics, and weaving fibrous materials.
44 J. Leigh—Treatment of gas produced by distillation of coal, cannel, bituminous shale, boghead, mineral oils, petroleum or other combustible substances, and obtaining certain products therefrom.
45 T. and T. Vicars, jun., & T. Ashmore—Bread and biscuits.
46 J. A Knight—Printing presses.
47 M. Hodgart—Pressing cotton.
48 E. V. Gardner—Treatment of petroleum and mineral oils.
49 J. G. Dahlke—Bricks and tiles.
50 G. Turner—Making leather from waste pieces of leather.
51 J. Whitworth & W. W. Hulse—Ordnance.
52 J. H. Johnson—Rocket torpedos.

DATED JANUARY 7th, 1863.

53 J. Neale—Capsules.
54 T. F Cashin—Covering wire, crinoline steel, or hoops for skirts.
55 W. Crabtree & J. Crowther—Perching and dressing textile fabrics.
56 W. S Broce—Lucifer matches and fosees.
57 T. Storey—Compound waterproof and ornamental fabrics.
58 W. Clark—Advertising.
59 G. C. Grimes—Treating splints for matches.
60 G. A. Huddart—Buttons.
61 T. Aveling—Traction engines.
62 G. Dowler—Match boxes.
63 G. T Bousfield—Skate fasteners.
64 H. Harben—Cleaning machinery.
65 J. H. Johnson—Permanent way of railways.

DATED JANUARY 8th, 1863.

66 R. Grogan—Propellers for vessels.
67 L. Hull—Treatment of ground caoutchouc.
68 A. Guild—Breaking and cleaning flax and hemp.
69 C. Allen—Signalling on railways.
70 R. T. & R. Monteith—dyes from aniline and its analogues.

DATED JANUARY 9th, 1863.

71 J. Punshon—Balance cylinder with counter-pressure, and the valves connected therewith, for stationary and locomotive steam engines.
72 C. Worssam—Lithographic press.
73 W. H Tucker—Locks
74 R. Thomas—Rendering hair wavy.
75 C. E. Gray—Wringing machines.
76 E. A. Goopil—Spherical wheel.
77 M. Cartwright—Alarums.
78 D. B. Parsons—Reaping and mowing machines.
79 E. T. Hughes—Printing woven fabrics, warps, and paper.
80 D Collinge—Preparing cotton to be spun.
81 W. H Moreland & J. Chappell—Winding, warping, beaming, or dressing machines.
82 G. B Price—Sights for fire-arms.
83 W. Tasker—Harrows.
84 M. Henry—Fornaces.

DATED JANUARY 10th, 1863.

85 W. Grove—Sawing and cutting wood.
86 W. Grove—Sawing wood.
87 R. Luthy—Hydrostatic presses.
88 M. Vogl—Fastening for bags.
89 L. H. E. Lepreux—Hygrometric plates.
90 F. Fenton—Pulp for paper making.
91 E. Powers & J. G. Dale—Caustic soda and potash.

DATED JANUARY 12th, 1863.

92 D. Dawson—Magenta colour or dye.
93 E. D. Chattaway—Railway signals.
94 E. Stevens—Ovens, hot plates, and cooking apparatus.
95 W. Clark—Winding or copping frames.
96 W. Clark—Carding engines
97 W. Clark—Green colouring matter.
98 A. I. Mahon—Screw, paddle, and submarine propellers.
99 W. E. Newton—Application of power designed for stationary and traction engines, propellers, and other machinery.

DATED JANUARY 13th, 1863.

100 T. G. Lewis—Perambulators, invalid chairs, and other chairs
101 J. B. Feuby — Apparatus to be attached to pianofortes, organs, and other similar keyed instruments for printing the score of any music performed on the said instruments.
102 T. Boyle—Comic stereoscope
103 D & J. Tannahill—Rivet-making machinery.
104 W. Platts & J Bailey—Telegraphic cables.
105 J T. Stroud—Fixed and portable lights
106 C. H. Townsend & J Young—Compositions for preventing incrustation and corrosion in steam boilers and condensers.
107 R. A. Brooman—Lifting bobbins off spindles in spinning machines, and lubricating spindles.
108 W. Southwood—Nails or brads.
109 M. Tildesley—Padlocks and other locks and keys.
110 C. E Amos—Paper.
111 L. Lescuyer—India rubber overshoes.
112 T. Butler—Lace.
113 J. B. Ruck—Saving life and property from fire and other danger in buildings and mines.
114 H. Bessemer—Treatment of malleable iron and steel.

DATED JANUARY 14th, 1863.

115 J. Kidd—Measuring the quantity of gas supplied to single burners, and increasing its illuminating power.
116 W. Pidding — Soles and heels of boots and shoes, and nails, tips, and toe or other plates.
117 J. A. Schlumberger—Colours for dyeing and printing.
118 J. S. Butler—Bobbin net made on bobbin net or twist lace machines.
119 G. T. Bousfield—Rolling, grinding, and cutting files.
120 G. A. Biddell—Pulping turnips and other vegetable substances.
121 B Burrows—Looms for weaving narrow fabrics.
122 J. Lawson—Holding castings and other pieces whilst being planed or shaped.
123 E. Morewood—Coated metallic sheets or plates and pieces.
124 Sweeping chimneys and preventing them from smoking
125 T Wilkinson—Tubular steam boilers.
126 W. Johnson—Chlorine and bleaching powder, carbonate of soda, and soda ash and sulphate of iron.

DATED JANUARY 15th, 1863.

127 H. Turner — Preventing and curing blight, decay, disease, and rot in potatoes, and other garden and farming produce.
128 W. Hulse & C. L. Haines—Taper metallic tubes.
129 E. Howes—Railway, ship, and other lamps.
130 T. C. Barraclough—Cutting metallic tubes.
131 T. C. Barraclough—Alarum apparatus.
132 J. Harrop—Treatment of organic fecal and urinous matters.
133 G. Graham—Turkey-red dyeing.
134 R. Fernier—Wet gas meters.
135 L. P. Josse—Cleansing wheat or other grain or seeds.
136 C. Murrell—Breech-loading fire-arms.
137 J. P. Bath—Carriages for tram and other roads.
138 C H. G. Williams—Colouring matters.
139 J. W. Child—Spinning and weaving.
140 A. Prince—Sewing machines.
141 W. E Newton—Microscopes.
142 D. F. Leblanc—Level indicator or liquid gauge.
143 R. A. Brooman—Looms for the manufacture of lace and other fabrics.

DATED JANUARY 16th, 1863.

144 J. Kerr—Stopping railway and other carriages.
145 L. Verdure—Slubs or rovings (in flax, hemp, and other filamentous materials), produced by the slubbing frame, and destined for fine spinning.
146 J. G. Winter & C. E. Gray—Vessels in which to cool and transport fatty or oleaginous matters
147 M. Moeglen—Printing several colours in succession on the same surface.
148 E. Loysel—Preserving valuable property in cases of shipwreck.

DATED JANUARY 17th, 1863.

149 W. Sborrock—Power looms for weaving.
150 J Edwards—Buttons.
151 J. Lightfoot—Printing and dyeing textile fabrics and yarns.
152 I. Ashe—Preventing sea sickness.
153 J. Combe—Spreading, drawing, and carding flax and other fibrous substances.
154 G. Haycraft—Powder flasks.
155 G. T. Boosfield—Hot-air engines.
156 W. E. Newtou—Buttons.

DATED JANUARY 19th, 1862.

157 E. Sabel—Artificial stone.
158 C. Norton—Roughing stone.
159 J. Laurie—Churning milk and mixing liquid compounds.
160 Sir W. O'Shaughnessy Brooke—Insulators for electric telegraphs.
161 H. Rushton—Plaiting cotton, thread, or other fibrous material over steels for crinolines.
162 R. A. Brooman—Sulphate of soda for conversion into soda
163 W. H. Harrison—Covering wire and other iron articles for the purpose of protecting them from oxidation.
164 J. J. Lundy—Metallic casks and vessels.
165 B. Van der Mark—Musical instrument called mark-harmonica.

DATED JANUARY 20th, 1863.

166 A. Paul—Obtaining reciprocating motion in steam engines.
167 J. Moshеimer—Crushing and grinding quartz and other substances.
168 J B ll—Carding engines.
169 W. Mawson & J. Whitehead—Hydraulic machinery for raising water in mines, wells, and other places.
170 H. A. Bonneville—Clocks.
171 H. A. Bonneville—Colouring, bronzing, and preserving iron and steel.
172 M. Henry—Apparatus for retarding and stopping railway carriages.
173 W. Clark—Looms for weaving textile fabrics.
174 J. Smith & S. A. Chease—Motive power engine.
175 H. Hughes & J. Sanders—Trimmings and cap fronts
176 S. Blackwell—Applying water or other fluid to the legs and other parts of horses and other animals.

DATED JANUARY 21st, 1863.

177 J. W. Meears—Sash frames and sashes, and suspending the same by atmospheric pressure or otherwise.
178 A. Phillips—Looms for weaving figured fabrics.
179 T. Wright—Cast iron pipes.
180 F. A. Busch—Metallic vessels or receptacles for containing liquids or substances.
181 J. M. Kirk—Finishing textile fabrics.
182 H. B. Barlow—Jacquard machines.
183 J. Holt—Willowing and opening cotton and other fibrous substances
184 A. Boubee—Casting or moulding articles in glass, and imitation of precious stones or marbles
185 W. Clark—Preparing and obtaining photogenic pictures and representations.
186 W. Clark—Desiccating and preserving matter from decay.
187 E. Bazin—Log.
188 C. H. Roeckner—Reducing wood to a fibrous condition, for the manufacture of paper stuff and pulp.
189 Sir C. Lindsay—Apparatus to be used on railways to indicate to the engine driver of a carriage train the length of time which has intervened since the passing of a previous train.
190 A. Pennington—Beating mats, rugs, and other like articles.
191 N. Clayton & J. Shuttleworth—Rotatory screens suitable for screening wheat and other grain or seed.
192 H. Caro—Obtaining colouring matters.
193 H. Holcroft—Separating substances of different specific gravities.

DATED JANUARY 22nd, 1863.

194 W. Harrison & B. Croasdale — Looms for weaving.
195 J. C. Brandes—Hair creaser or divider.
196 J. Grant—Sidings and loop lines for railways or tramways.
197 J. Ellacot — Spur wheels, racks, and other toothed gear to insure greater strength in the teeth
198 J. M. Binger—Composition of a kind of pulp proper for the manufacturing of printing and typographical rollers.
199 R. Penney—Fixing colours employed in printing calico and other fabrics.
200 W. & J. Blackwood—Drying yarns or threads.
201 W. Clark—Piston valves and other pistons.
202 N Wood and J Stockley—Grinding, smoothing, and polishing plate glass
203 T Lambert — Drawing off water and other fluids
204 C Langley—Facilitating the repairs of ships and other structures
205 F W Marley—Boilers for steam engines, and valves to be used therewith

DATED JANUARY 23rd, 1863.

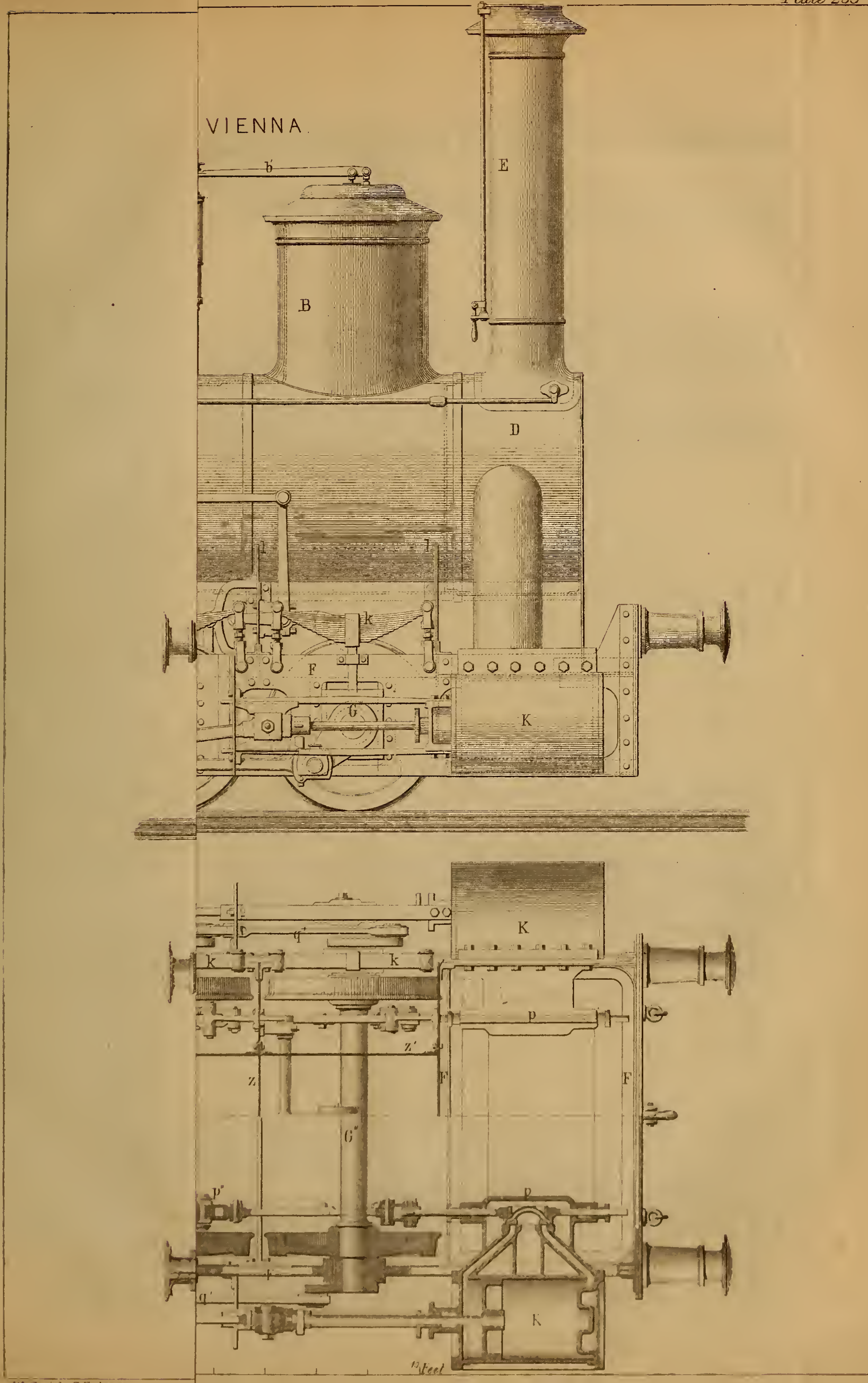
206 J Milner—Steam engines
207 A Henderson—Textile materials
208 E Strangman—Pipes
209 C Stopford—Hats
210 F N Gisborne—Signals on board ship and indicating the position of the rudder
211 W Clark—Mariners' compasses
212 P A Cole—Collars, cuffs, wristbands, shirt-fronts, habit-shirts, and petticoats
213 C Turner—Felted fabrics
214—E T Hughes—Breech-loading fire-arms

DATED JANUARY 24th, 1863.

215 A O Glossop—Breakfast cruet, liquor, and other frames
216 W Mellor and W Whaley—Steam hammers and other engines driven by steam
217 W Allen and W Johnson—Grinding the cards employed in carding engines
218 E Shackleton—Looms for weaving
219 E and G Booth and A Swallow—Fixing colouring matter on cotton, silk, and wool
220 M A F Mennous—Punching and cutting metals
221 W Clark—Syphons
222 A J Sax—Rendering drum-skins and gut-strings less liable to hygrometric influences
223 R A Brooman—Anvils
224 F Tolhausen—Looms for weaving
225 F Tolhausen—Carding fibrous materials

DATED JANUARY 26th, 1863.

226 W F Stanley—Mathematical drawing instruments
227 J Barraclough—Railway engines
228 A Smith—Staples, locks, bolts, and latches
229 J Fyfe—Safety apparatus for steam engines
230 A L Liétout and J B Roisin—Gymnastical apparatus for medical purposes
231 R A Brooman—Petticoats or crinolines



W. Smith C.E. direx

OCOMOTIVE ENGINEERING.

FIG. 4.

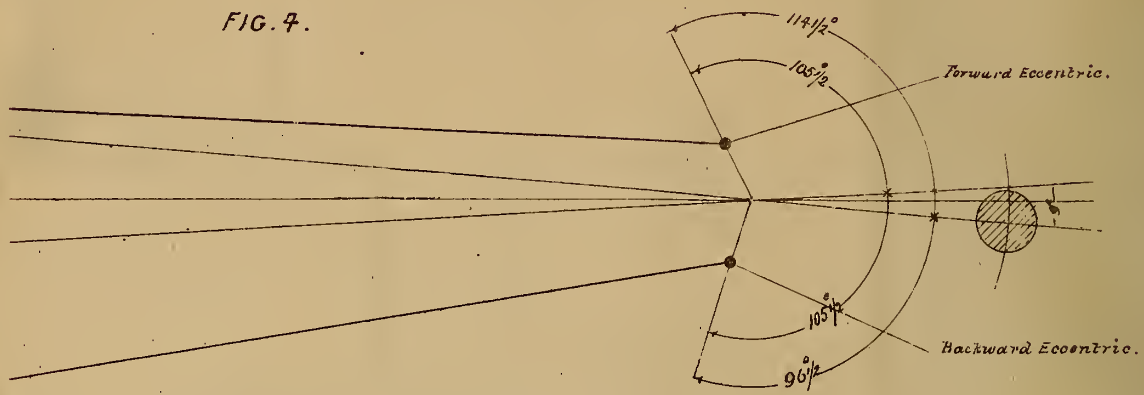
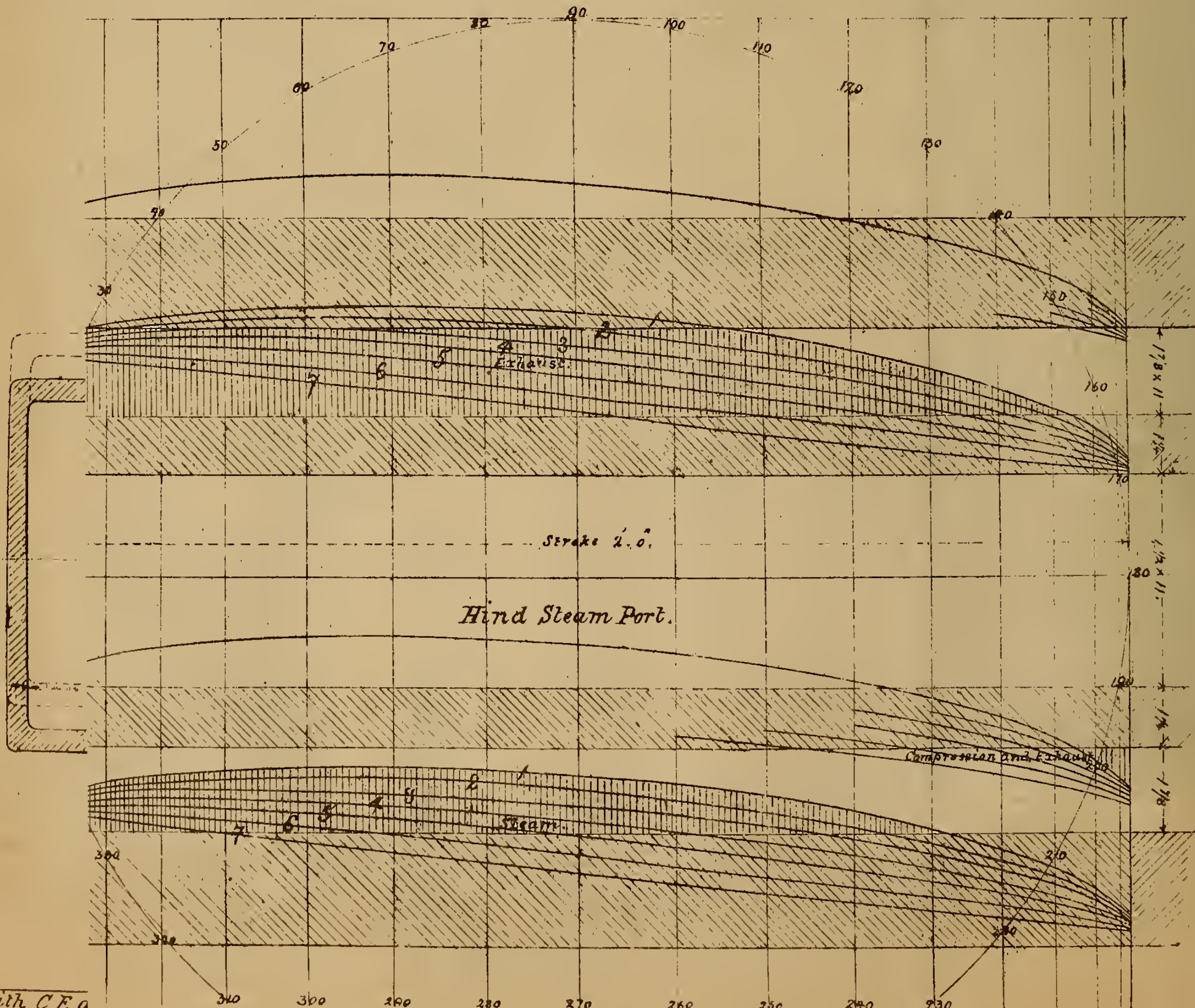


FIG. 3.



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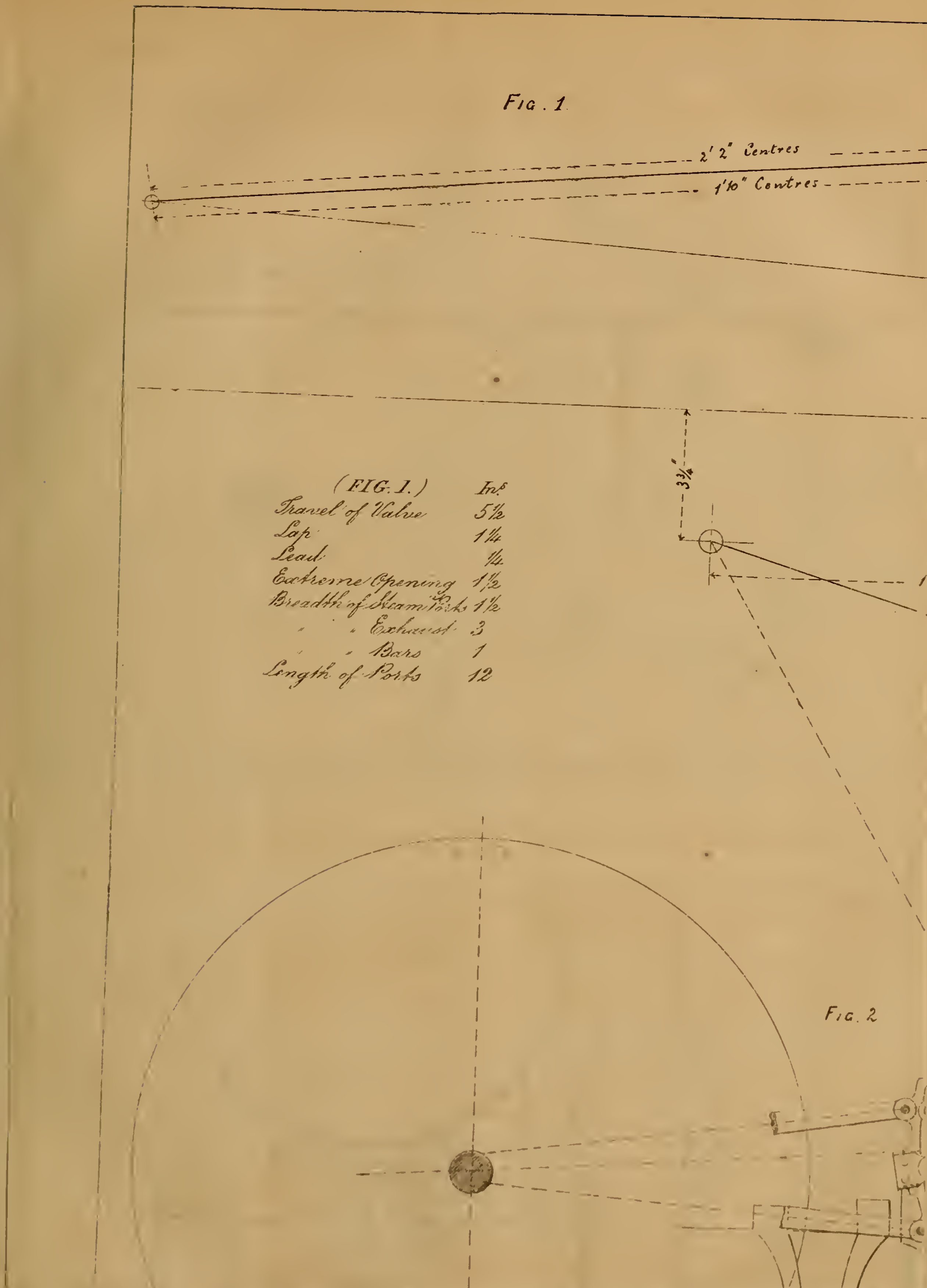


$$12429 = 5{\cdot}3145 \times 7 \times d^2$$

$$d = \sqrt{\frac{12429}{37{\cdot}2015}} = 18{\cdot}2 \text{ inches} \quad \ldots \quad \ldots \quad (3.)$$

Exterior lap of slide	$1\frac{1}{4}$in.
Interior " "	$\frac{7}{32}$in.
Lead of the slide	$\frac{1}{8}$in.
Largest opening for inlet of steam	$1\frac{3}{32}$in.
" " for exhaust of steam	$1\frac{9}{16}$in.

GOODS LOCOMOTIVE "STEIERDORF"

CONSTRUCTED AT THE WORKS OF THE I. R. AUSTRIAN STATE RAILWAY Co., VIENNA

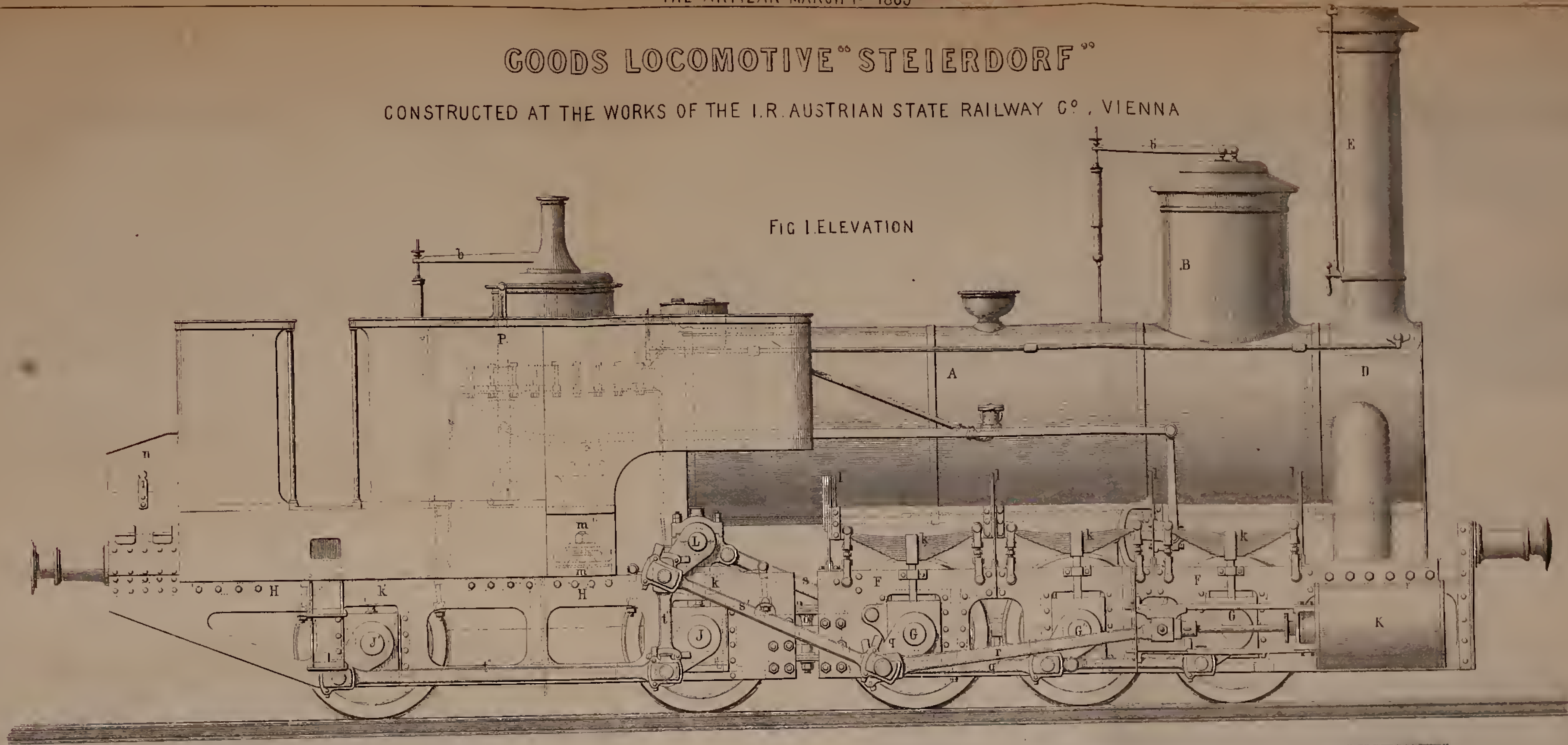


FIG 1. ELEVATION

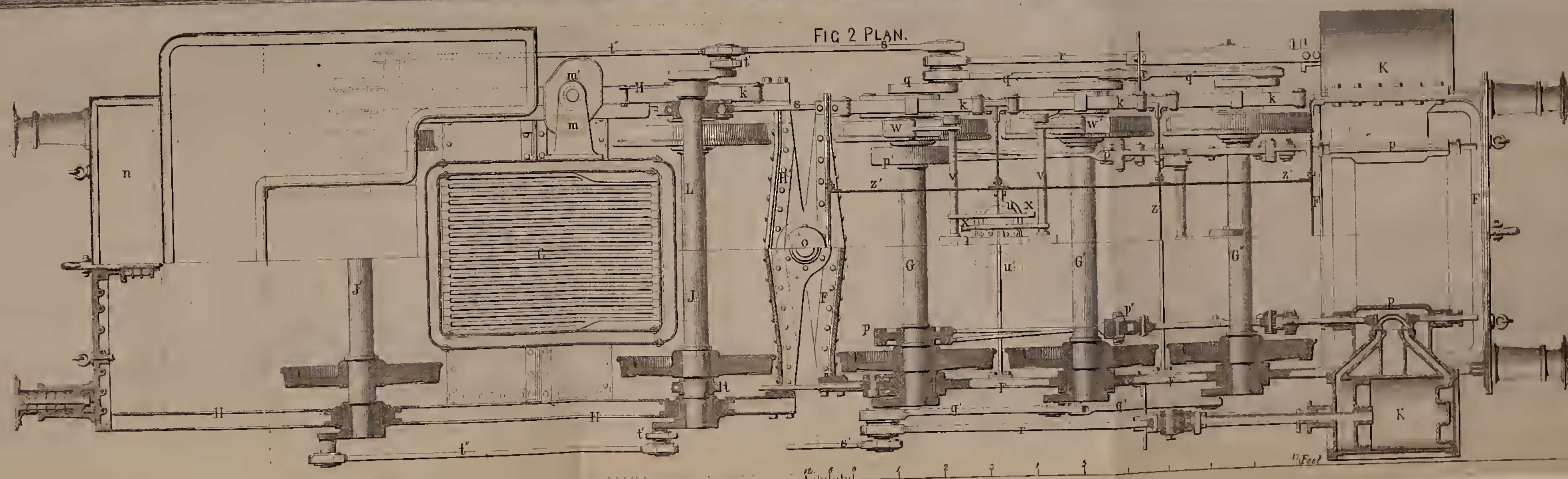


FIG 2 PLAN.

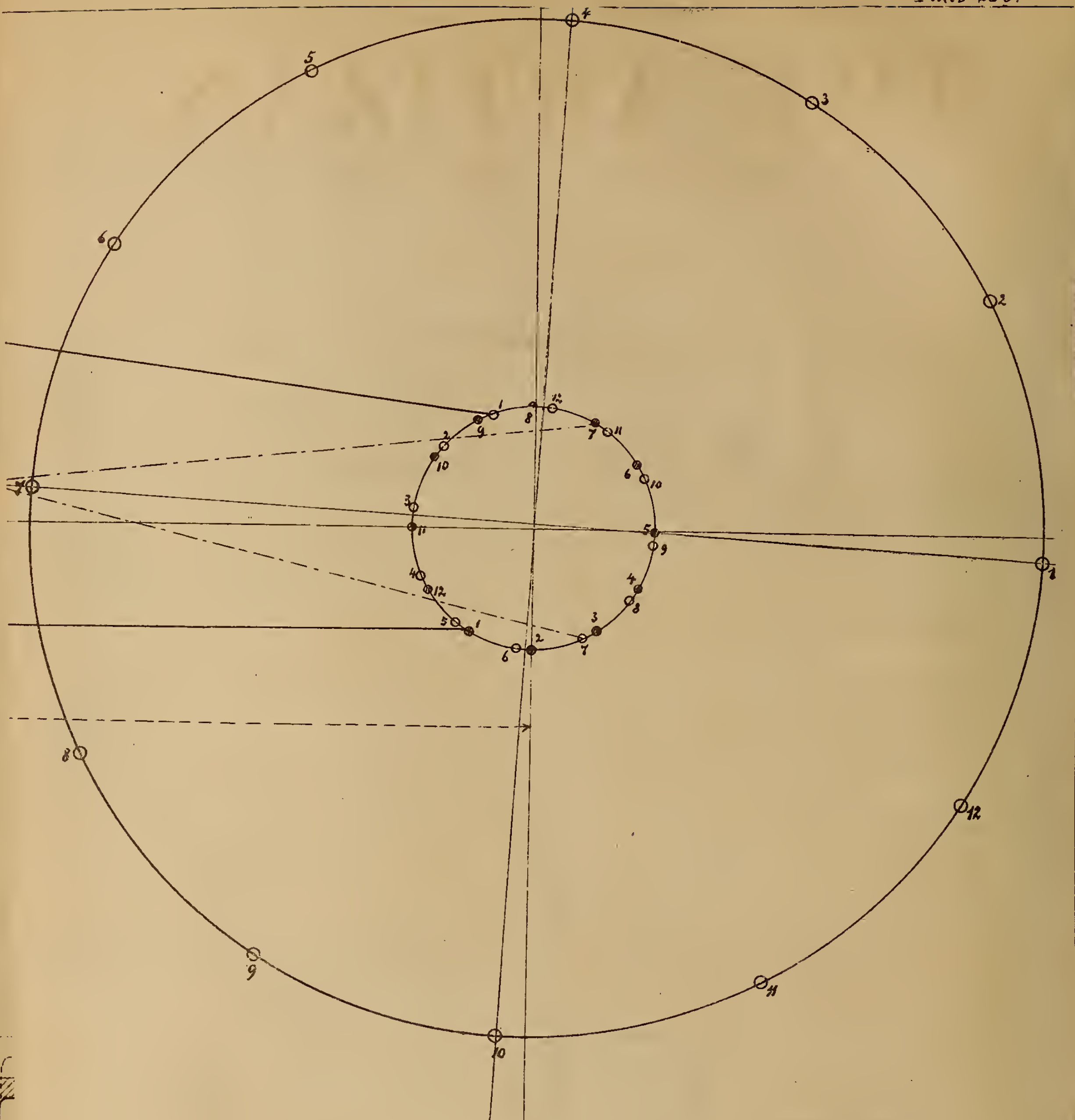
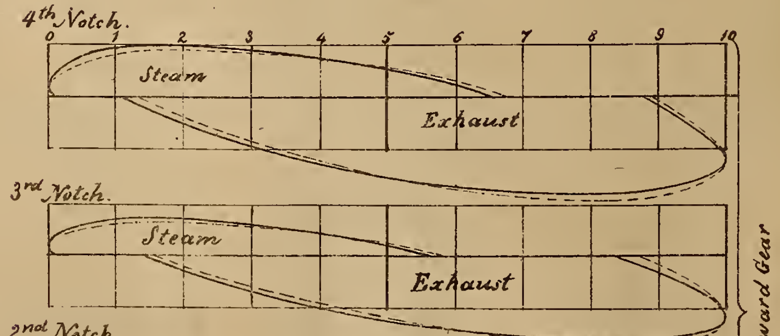
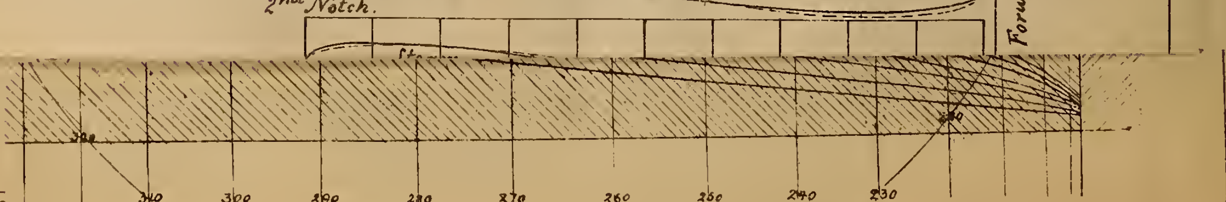


Fig. 4.





W. Smith, C.E. a

THE ARTIZAN.

No. 3.—Vol. 1.—Third Series.

MARCH 1st, 1863.

GOODS LOCOMOTIVE "STEIERDORF."

Constructed at the Works of the I. R. Austrian State Railway Company, Vienna.

(Illustrated by Plate 233.)

In The Artizan of December last we gave a plate illustration and description of the express locomotive "Duplex," constructed at the Works of the Imp. R. Austrian State Railway Company, Vienna. The plate with this number illustrates, in side elevation and by a sectional plan, a goods locomotive, constructed at the same works, and designed to run on the line of railway between Oravicza and Steierdorf, being a portion of the Austrian Snedostbahn. This line attains as high a gradient as $\frac{1}{50}$, and contains curves of a radius of 370ft. within a length of 10·6 miles, the maximum weight of the trains on the gradient being about 110 tons; the speed not to exceed 7 to 9 miles per hour. The aggregate tractive power required under these conditions had been computed at 103·4 cwts. = 5·17 tons, viz.,

The tractive power on a level at 2200 : 260	= 8·4 cwt.
The tractive power required for passing over curves of 370ft. radius supposed to be 2·5 × the tractive power on a level	= 21·0 cwt.
The tractive power required to overcome the relative weight of the train 2200 : 50	= 44·0 cwt.
Ditto, to overcome the relative weight of the locomotive and tender 900 : 50	= 18·0 cwt.
Total	91·4 cwt.
To be added the power required by the engine to move itself on the horizontal curved line $\frac{900}{260} \times 3·5$	= 12·1 cwt.
Aggregate tractive power.........	= 103·5 cwt.

Supposing the coefficient of friction to be = 1 : 7 the weight of adhesion of the engine would be 724·5 cwts.; and taking into account the various impediments, it would amount to 800 cwt. = 40 tons. The maximum load on each axle being 190 cwt., 5 driving axles were required for the motion. The aggregate weight to be dragged being 91·4 cwts., the speed for a gradient of 1 : 50 being 7·5 miles per hour, or 660ft. per minute, the strength required for the engine is

$$\frac{10237 \times 660}{33000} = 204·74 \text{ say } 205 \text{ H.P.} \quad \ldots\ldots\ldots \quad (1.)$$

Taking 6·454 square feet as the heating surface for 1 H.P., we have

6·454 × 1322 square feet aggregate heating surface.
Diameter of driving wheels D = 3·2ft.; stroke of piston l = 2·07ft.

Calling p the working pressure on each piston, after deducting the resistance of the working parts of the engine to overcome the resistance Z of the train, we have

$$2\,p \times 2\,l = \pi\,D\,Z,$$

and hence,

$$p = \frac{\pi}{4} \times \frac{D}{l} \times Z = 12{,}429\text{lbs.} \quad \ldots\ldots\ldots\ldots\ldots \quad (2.)$$

If d denotes the diameter of the cylinder in inches,
n the pressure in atmospheres of 14·71lbs. per square inch.
k = 0·46 the average useful pressure of steam in cylinder,

we have

$$p = 0·46 \times 14·71 \times n\,\frac{d^2\,\pi}{4} = 5·3145\,n\,d^2$$

Taking

$$n = 7,\ p = 12429,$$

$$12429 = 5·3145 \times 7 \times d^2$$

$$d = \sqrt{\frac{12429}{37·2015}} = 18·2 \text{ inches} \quad \ldots \quad \ldots \quad (3.)$$

The following is the list of dimensions of the several parts of this locomotive:—

Fire Grate.

Length	4ft. $9\frac{7}{8}$in.
Width, fore	2ft. $10\frac{15}{16}$in.
„ aft	3ft. $3\frac{3}{4}$in.
Area	15·06 sq. ft.
Number of grate bars	23
Distance of grate bars from each other	$\frac{15}{16}$in.

Fire Box.

Internal length, at the bottom..............................	4ft. $9\frac{7}{8}$in.
„ „ at the top	4ft. $7\frac{3}{8}$in.
Internal breadth at the bottom, front......................	2ft. $10\frac{15}{16}$in.
„ „ „ back......................	3ft. $3\frac{3}{4}$in.
„ „ „ top	3ft. $8\frac{7}{16}$in.
Internal height, front..	4ft. $4\frac{13}{16}$in.
„ „ back..	3ft. $11\frac{5}{8}$in.
Height from fire door to bottom of fire box	1ft. $6\frac{3}{16}$in.
Thickness of copper plate	$\frac{5}{8}$in.
„ of the tube plate, top	1in.
„ „ „ bottom	$\frac{5}{8}$in.
Diameter of copper stay bolts	1in.
Distance of „ „	4in.

Barrel.

Length to the tube plate in the smoke box...............	14ft. $2\frac{1}{16}$in.
Largest diameter..	4ft. $\frac{3}{4}$in.
Smallest „	3ft. $10\frac{11}{16}$in.
Thickness of plate	$\frac{1}{2}$in.
Diameter of rivets	$\frac{3}{4}$in.
Distance of same from each other	$1\frac{13}{16}$in.
Number of tubes..	158.
Internal length of tubes	14ft. $6\frac{1}{4}$in.
External diameter of tubes	$2\frac{1}{16}$in.
Thickness of copper of tubes	$\frac{3}{32}$in.
Distance of tubes from centre to centre	$2\frac{3}{4}$in.
Number of safety valves	2
Diameter of „	$4\frac{3}{8}$in.

Heating Surface.

Heating surface of the tubes	1244·5 sq. ft.
„ „ of the fire box..............................	78·5 sq. ft.
Aggregate heating surface....................................	1323· sq. ft.

Chimney.

Diameter of funnel..	1ft. $4\frac{9}{16}$in.
Height of mouth of funnel above the rails	14ft. $8\frac{5}{16}$in.

Blast Pipes (Moveable Valves).

Area of largest opening	24·9 sq. in.
„ of smallest „	4·7 sq. in.

Feed Pumps.

Two patent Giffard injectors, No. 9.

Regulator.

Area of aperture..	7·8 sq. in.

Steam Cylinders.

Diameter of cylinders..	1ft. $6\frac{1}{4}$in.
Length of stroke..	2ft. $\frac{3}{4}$in.
„ of steam ports	1ft. $\frac{3}{4}$in.
Width of „ „	$1\frac{9}{16}$in.
„ of exhaust ports..	$3\frac{1}{4}$in.

Slide Valves and Reversing Gear.

External length of the slide	$10\frac{3}{4}$in.
Internal „ „	$6\frac{1}{4}$in.
External width	1ft. $3\frac{1}{16}$in.
Internal „	1ft. $\frac{7}{16}$in.
Area of the slide valve	108·8 sq. in.
Exterior lap of slide	$1\frac{1}{4}$in.
Interior „ „	$\frac{7}{32}$in.
Lead of the slide..	$\frac{1}{4}$in.
Largest opening for inlet of steam	$1\frac{5}{32}$in.
„ „ for exhaust of steam........................	1[illegible]

LOCOMOTIVE ENGINEERING.

FIG. 1.

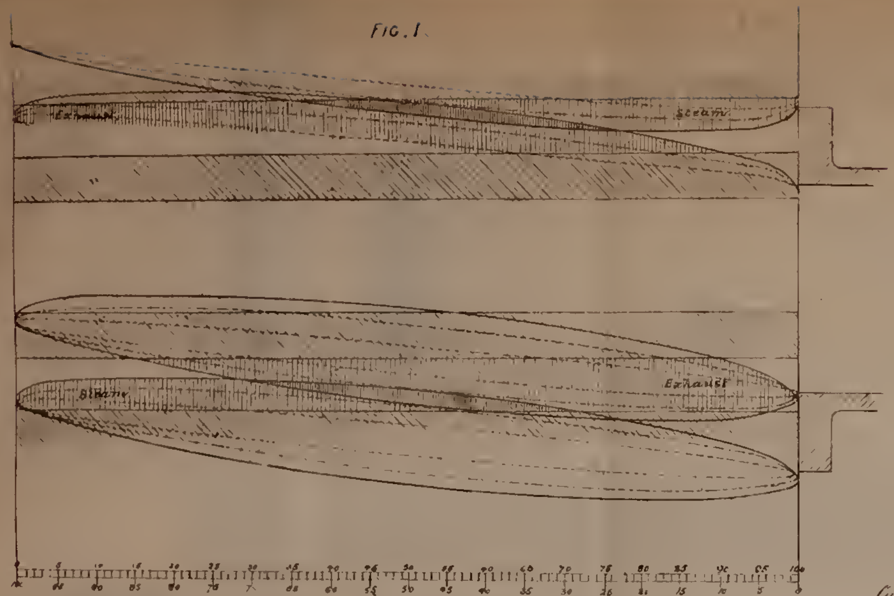
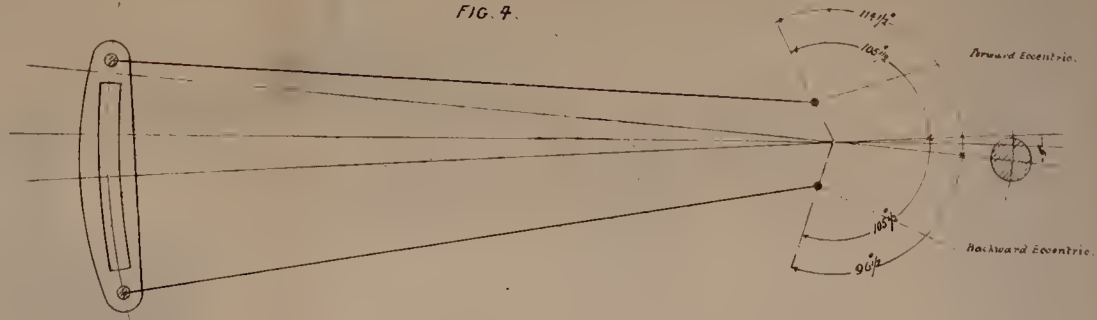


FIG. 4.



Curve No 1 Angle 105½ Lap 7/8 inch
Throw of Eccentrics 5 inches.
Traverse of Valve. 4½

No 2	4¼.
No 3	3⅝
No 4	3⅛.
No 5	2 13/16.
No 6	2 9/16.
No 7	2½.

FIG. 2.

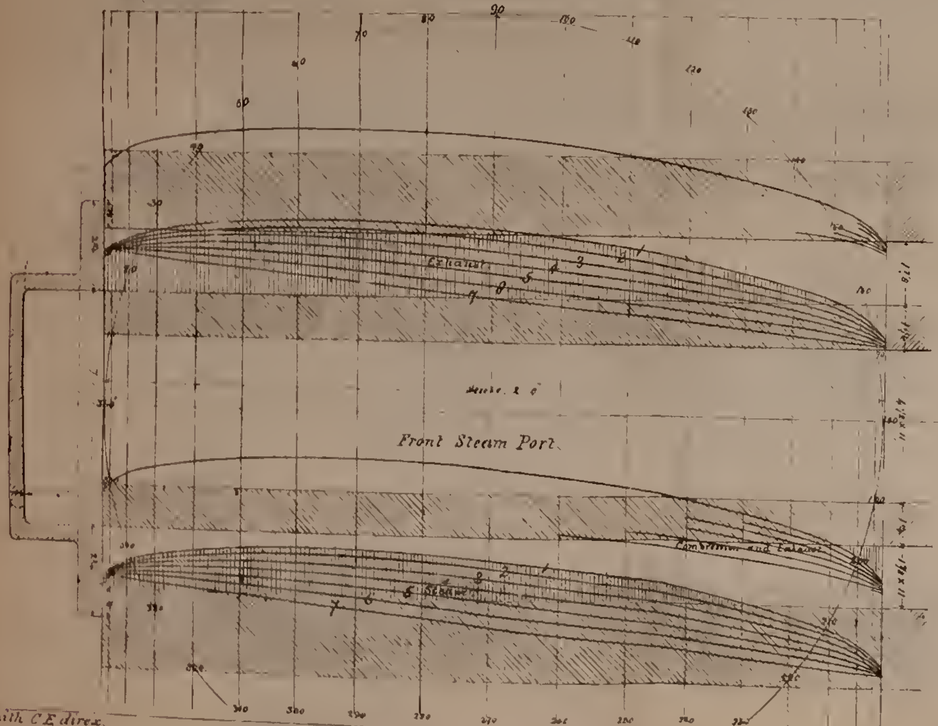
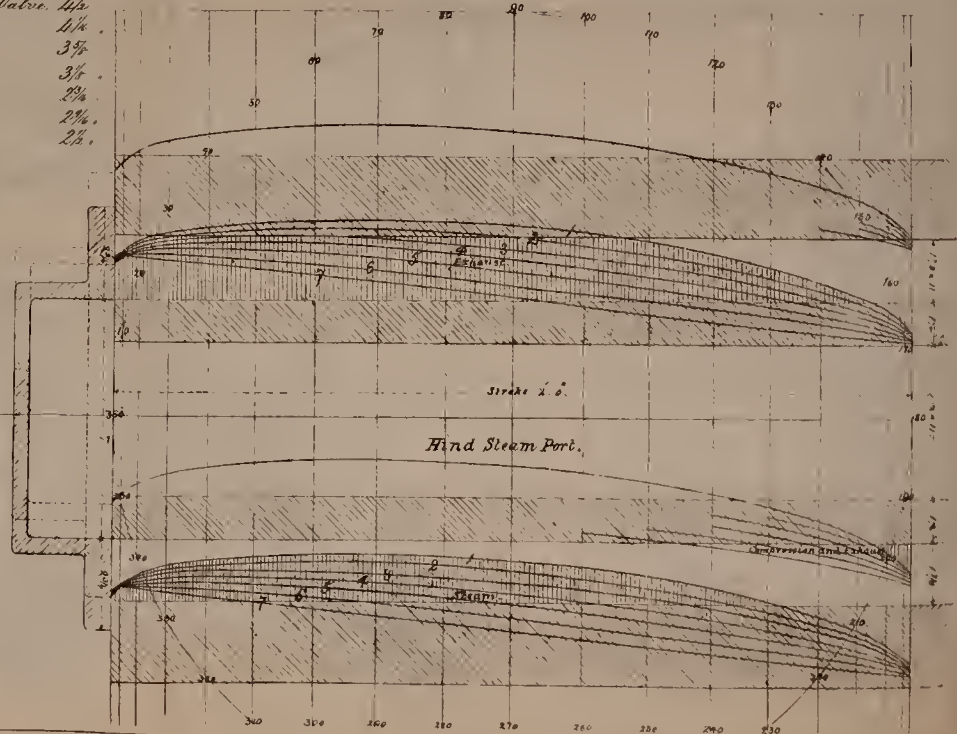


FIG. 3.



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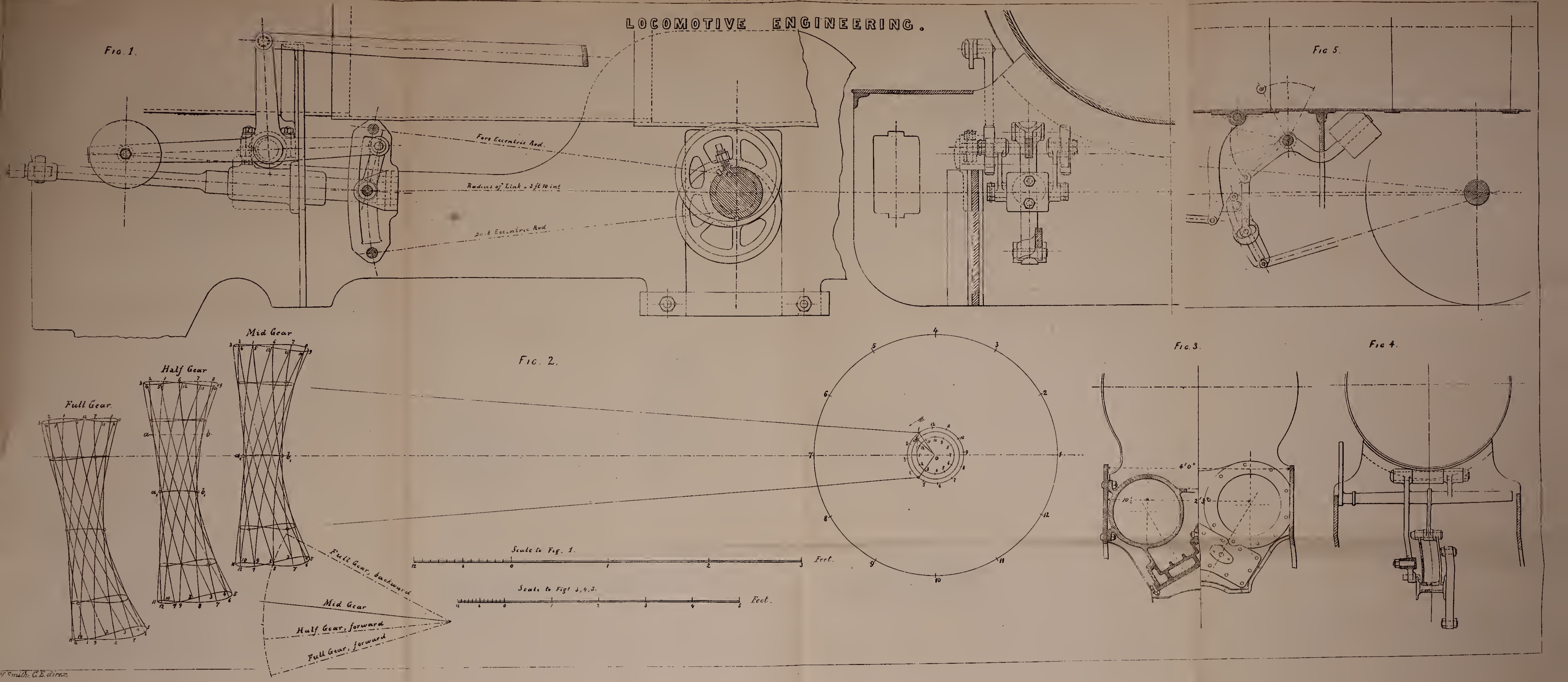
LOCOMOTIVE ENGINEERING.



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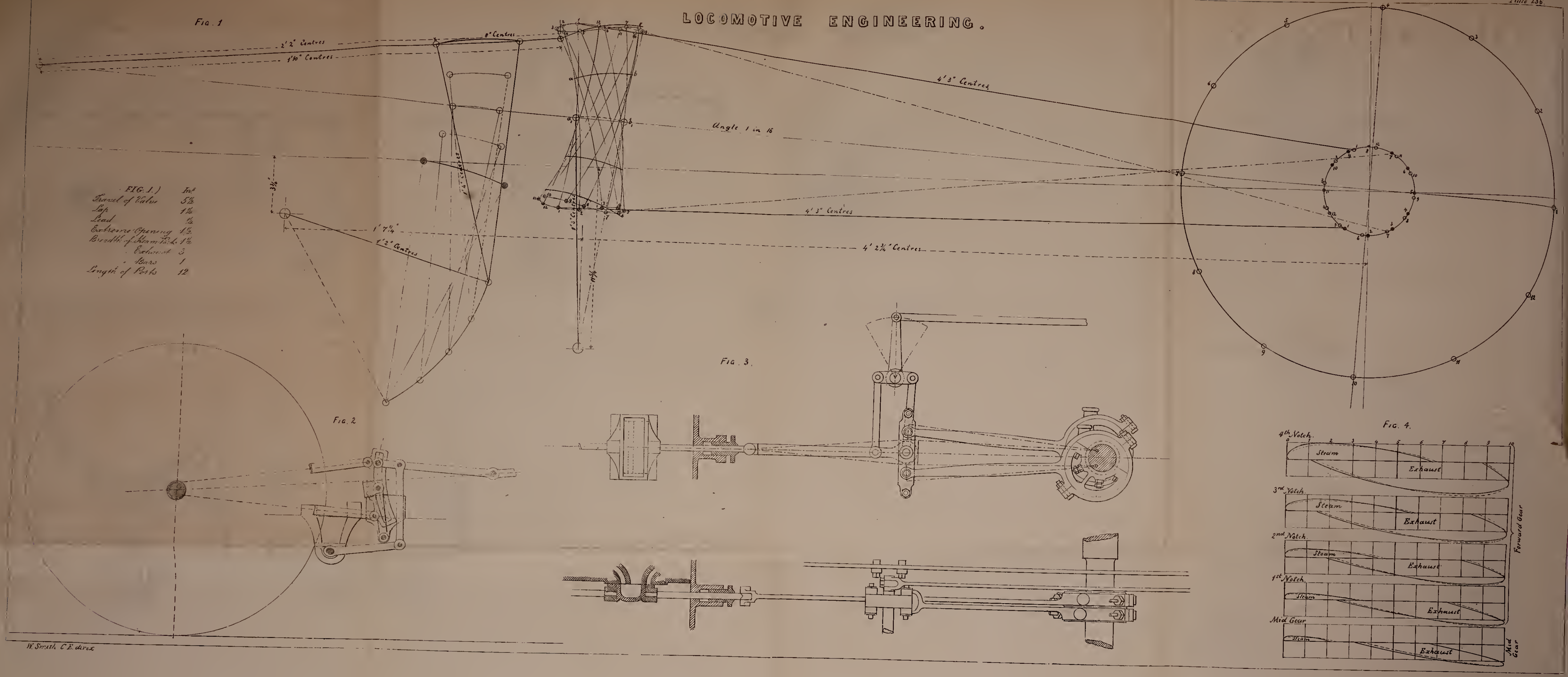
LOCOMOTIVE ENGINEERING.



Shutting off of steam in cylinders	66 per cent.
Largest travel of slide	$4\frac{5}{16}$in.
Throw of eccentrics	$6\frac{7}{32}$in.
Angle of lead, forward	15°.
" " backward	15°.
Length of eccentric rod	4ft. $6\frac{15}{16}$in.
Radius of link segment in the middle	3ft. $6\frac{1}{2}$in.
Length of link segment	1ft. $4\frac{1}{16}$in.

CONNECTING AND COUPLING RODS.

Length of connecting rod	6ft. $4\frac{3}{4}$in.
" of front draw bar	3ft. $1\frac{7}{8}$in.
" of back draw bar	3ft. $7\frac{9}{16}$in.
" of draw bar for tender	7ft. $3\frac{1}{8}$in.

COUPLING OF THE TWO TRAINS.

Length of coupling shaft from centre of bearing	5ft. $\frac{11}{16}$in.
Total length of " " "	7ft. $6\frac{1}{2}$in.
Diameter of " " "	$5\frac{3}{16}$in.
Length of the vertical link between the first tender axle-tree and coupling shaft	2ft. $0\frac{7}{8}$in.
Largest section of ditto	16·1 sq. in.
Length of oblique coupling rods between driving shaft and coupling shaft	5ft. $2\frac{1}{4}$in.
Largest section of ditto	5·5 sq. in.
Length of the vertical draw bars between the first tender axle-tree and the coupling shaft	2ft. $0\frac{7}{8}$in.
Largest section of ditto	4·8 sq. in.

WHEELS.

Number of wheels	10
Diameter of "	3ft. $3\frac{3}{8}$in.
Width of Tyres	$5\frac{1}{4}$in.
Taper of "	$\frac{1}{10}$in.
Total length of wheel base	19ft. $3\frac{1}{4}$in.
Distance from first to central axle	3ft. $7\frac{9}{16}$
" Central to driving axle	3ft. $7\frac{9}{16}$
" Driving to first tender axle	4ft. 9in.

TENDER.

Capacity for water	160 cub. ft.
" for fuel	60 cub. ft.

BUFFERS.

Height above the rails	3ft. $6\frac{1}{2}$in.
Distance from centre to centre	5ft. 9in.

MAIN EXTERNAL DIMENSIONS OF ENGINE.

Length between surfaces of front and back buffers	33ft. $10\frac{9}{16}$in.
Largest width of engine (measured on the cylinders)	9ft. $8\frac{11}{16}$in.

TOTAL WEIGHT OF THE ENGINE IN WORKING ORDER.

Load on rails from the 1st axle-tree	9·153 tons.
" " 2nd "	8·267 "
" " 3rd "	9·694 "
" " 4th "	6·791 "
" " 5th "	12·106 "
Total	46·011 tons.

We also purpose presenting our readers in our next issue with another plate engraving, containing sectional views of the "Steierdorf," accompanied with a series of woodcuts and descriptive particulars.

A CRITICAL AND HISTORICAL REVIEW OF LOCOMOTIVE ENGINEERING.

By J. J. BIRCKEL.

(*Continued from page* 29.)

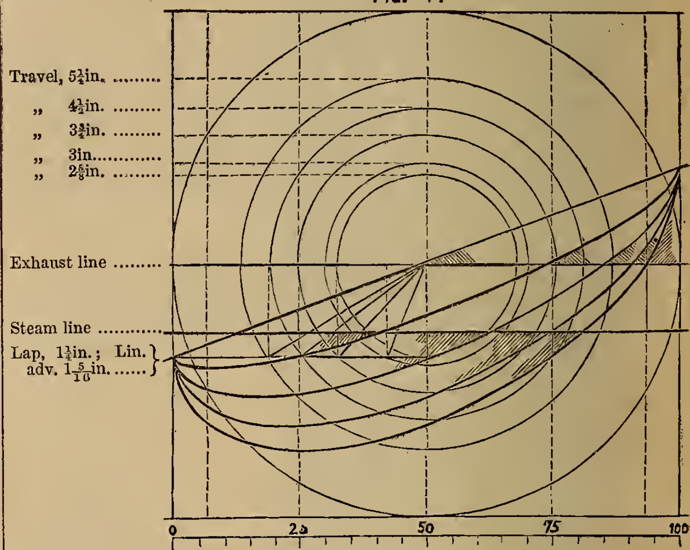
(*Illustrated by Plates Nos.* 234, 235, *and* 236).

We have seen that the distribution of the steam by means of the slide valve, so far as regards the periods of admission, suppression, and release, is regulated by the lap and the lead; and having stated also that variable and long expansion is obtained by great lap, accompanied with variable travel, we now give a graphic demonstration of this statement for the satisfaction of our readers by the annexed motion diagrams (Figs. 1, 2, 3, &c.) of a valve supposed to have one inch lap, and $\frac{5}{16}$ lead with a travel varying from $5\frac{1}{4}$ to $2\frac{5}{8}$ inches. These diagrams show that the points of suppression keep shifting at a rapid rate towards the beginning of the stroke as the travel is reduced, but the ratios, as given in the following table, will perhaps render the fact much more apparent.

Travel.		Period of Admission.	
Inches.	Per centage of Maximum Travel.	Per cent. of Stroke.	Per cent. of Max. Admission.
$5\frac{1}{4}$	100	81·5	100
$4\frac{1}{2}$	85·7	73·5	90·1
$3\frac{3}{4}$	71·4	60·	73·6
3	57·1	39	47·8
$2\frac{5}{8}$	50	12	14·7

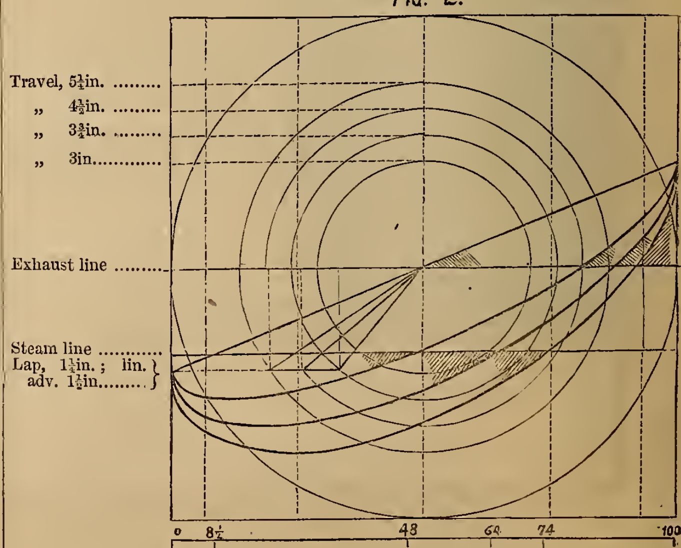
These figures, we think, strongly support the opinion already expressed in favour of a great initial travel of valve, since it is evident that with constant lap and lead it affords a greater range for variation in the rate of expansion.

FIG. 1.



The object of the link motion is to obtain variable expansion by means of variable travel with constant lap, and the amount of lap, so far at any rate as we have been able to ascertain, is subject to no other law in actual practice than the particular fancy of each designer, and ranges from

FIG. 2.

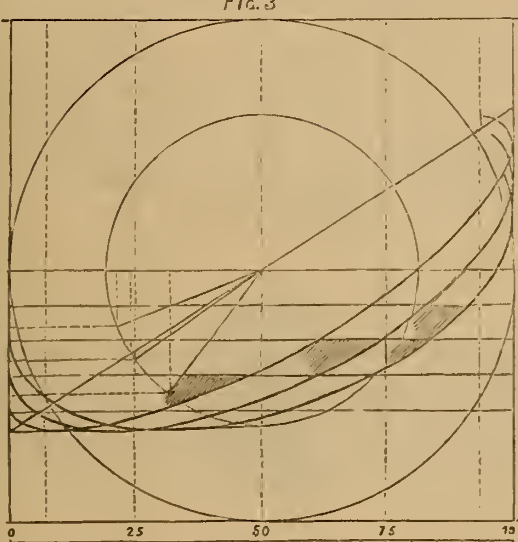


$\frac{7}{8}$ to $1\frac{1}{4}$ inch in locomotives of the same power or description. We think it somewhat strange that there should be such a large margin for variation in a matter like this, the relative results of which are so easily compared by diagrams representing the motion of the valve; the accompanying diagram (Fig. 2) for instance, being that of a valve having $1\frac{1}{4}$in. lap, with the lead nearly as before, shows that the sole addition of $\frac{1}{4}$in. to the lap reduces the periods of admission to 74, 64, and 48 per cent., being an increase of $7\frac{1}{2}$, $9\frac{1}{2}$, and 12 per cent. of the stroke in the expansive action of the steam, as compared with the results obtained by the corresponding amounts of travel in the previous example; this comparison, we think, is sufficient to show that the large lap has a claim to preference, if increased expansion is a guarantee of economy. It is true that the periods of release of the steam calculated from the opposite end of the stroke increase very rapidly with the decrease of the period of admission, but the loss of useful work thus occasioned is really too small, especially in the case of engines running at very high speeds, to be taken into account, when it is remembered how great is the gain upon back pressure due to this same circumstance.

The foregoing comparison naturally leads to the inference that variable expansion may be obtained also by varying the lap, and this virtually is the case in Meyer's expansion gear, illustrated by Fig. 9, plate 231, of THE ARTIZAN of last month, in which the removal of the expansion blocks from the centre of the valve face amounts to an increase of lap.

The annexed diagram (Fig. 3), illustrates the motion of a valve with lap

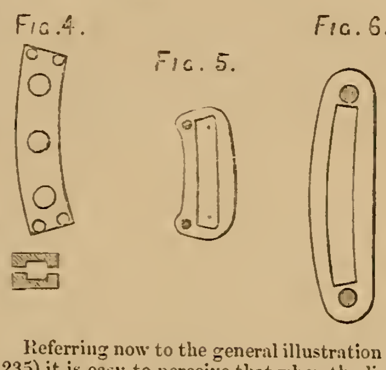
FIG. 3



varying from $\frac{1}{2}$in, to $1\frac{5}{16}$in., and from comparison with Figs. 1 and 2, it may be ascertained that the period of expansion does not increase at the same rapid rate as with varying travel, while at the same time, the period of release is considerably retarded, especially with the shorter laps; this circumstance, which is certainly favourable to engines working at low speeds, may be very unfavourable to engines working at high speeds, and upon the whole variable expansion by means of variable travel with constant lap is to be preferred.

With reference to the link motion and to its history, no sooner had it found its way into practice than human ingenuity applied itself to the task of modifying and improving it, and as a consequence, we have to make known to our readers three distinct types of link motions, namely: 1st. Stephenson's original motion known as the *shifting link*; 2nd. *The stationary link*, originated by Mr. Gooch, of the Great Western Railway: 3rd. The *straight link*, originated by Mr. Allan, of the Scottish Central Railway, and we shall proceed upon our investigation in the order just named, because this is the chronological order of their appearance, and of their recognition as mechanical entities.

The arrangement of the shifting link may be generally illustrated by Fig. 1 (plate 235,) which happens to be a representation of the valve motion of Mr. Ramsbottom's engine "Lady of the Lake," and consists of a slotted motion link curved to the radius of the eccentric rods and suspended from the arms of the reversing shaft; the points of connection of the eccentric rod ends with the link, vary according to convenience or necessity, and the engine is reversed or the rate of admission altered by lowering or raising the link through the medium of contrivances to be described hereafter,—the effect of thus lowering or raising the link is to cause the valve rod to be commanded either by the forward or backward eccentric, and the valve rod itself is either guided in a bush as in the case illustrated, or is suspended from some fixed point in such manner that it may move in a horizontal plane with as little vertical vibration as possible; it will be noticed, also, that the system of eccentric rods and links suspended on one side of the reversing shaft is balanced on the other side by a suitable counterweight for easiness of reversing. The link in each of the three types of motions is generally of two kinds, namely, the open link as illustrated by Figs. 5 and 6, and the box link as illustrated by Fig 4. The choice in the use of either kind s often made by considera-ions of economy and sometimes y considerations of expediency r of local necessity, although, s we shall have occasion to how, the relative positious of the points of suspension and of connection with the eccentric rods have a material influence upon the distribution of the steam, and it will be seen on reference to the illustrations, that the box link affords the better means of variation in the position of the points of connection.



Referring now to the general illustration of the shifting link motion (plate 235) it is easy to perceive that when the link stands in its middle or neutral position, if the forward and backward eccentrics were placed exactly opposite each other, both having the same radius or throw, it would pivot upon its point of suspension, which would remain stationary, and as in this position of the link the head of the valve rod is either exactly or nearly concentric with that point, the valve also would remain stationary; if on the contrary the link was raised or lowered a certain extent, the valve would receive motion either from the backward or forward eccentric and the ratio of that motion, to the throw of the eccentrics, would be exactly the same as the ratio of the distances of the centre of the valve spindle and of the centre of the eccentric rod ends to the point of suspension of the link which would still remain stationary. From these considerations we learn that the motion of the valve as received through the medium of the link remains similar to and isochronous with the motion which it would receive directly from a single eccentric, so long at any rate as the two eccentrics remain diametrically opposite each other; this condition, however, becomes an impossibility when, with a view to obtaining long expansions, the valve is to have a certain amount of lap, and when, to ensure the easier working of the moving parts of the engine, it is to have a certain amount of lead; for as under these circumstances the valve must have travelled beyond its middle position by the whole amount of lap and lead when the piston is at the end of its stroke, it follows that the eccentric must stand at such an angle with the crank, that its normal projection upon the straight line passing through the two extreme positions of the crank, referred if need be to the centre line of motion of the valve, and measured from the centre of the crank, be equal to the sum of lap and lead. This projection is called the *linear advance* of the eccentric. Hence in reality the smallest motion of which the valve is capable is equal to twice the sum of lap and lead, and from the study of the motion diagrams of the link, Figs. 2 (plates 325,) it may be ascertained that the motion of the valve is the same exactly that it would be if it was driven from two eccentrics, the one remaining in the position above described with its present throw, and the other applied to the centre of the link but placed exactly opposite the crank and with a throw equal to twice the sum of lap and lead only; it may be seen also that the motion of the valve when the link stands in its middle or neutral position is exactly like that derived directly from the latter named fictitious eccentric, and that the valve is at one end of its stroke when the crank is at the opposite end; but the closer the point of the link to which the end of the real eccentric rod is applied, is shifted to the centre line of motion of the valve, the nearer becomes the motion of the valve, like that derived from the original single eccentric. We have dwelt at some length upon this point because it had been held for a long time that there was something very mysterious and incomprehensible in the cinematical manifestations of the link motion taken from the motion of the valve, and we doubt whether even Mr. Clark, who has dealt with the subject in a manner fully befitting its importance, has thoroughly understood the nature of that motion, for the following is all that he says on the subject:—

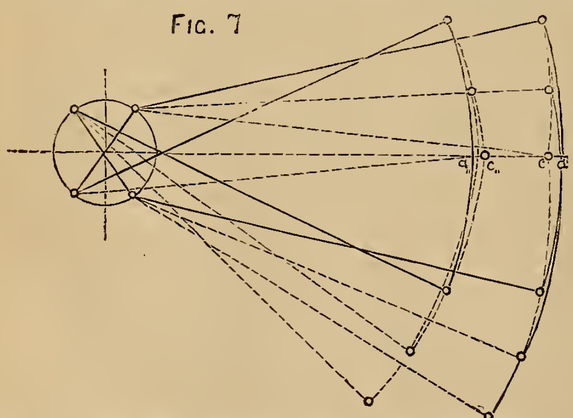
"The motion yielded by the link is apparently not so simple in its character as that of the single eccentric; throughout the whole length of the link it is a compound of the motions imparted separately by each eccentric, excepting only at the points where it joins the eccentric rods. Though the motion of every other point of the link is so compounded, the motion of each eccentric nevertheless predominates in its own half of the link above and below the point of suspension, and results in a motion com-

municated to the valve of which each reciprocation has a varying velocity accelerated and retarded like that yielded by the single eccentric."

This, no doubt, is correct, but it leaves the reader in the dark as to the nature of the motion yielded by the middle of the link, whereas the introduction of the fictitious eccentric as has been done above, solves that question altogether, and besides, has the advantage of teaching us that the motion of the valve, as the middle of the link is shifted towards the centre of the valve rod, does gradually merge from that yielded by a single eccentric placed at the proper angle of advance, to that yielded by a single eccentric of smaller radius and placed right opposite the crank. The motion diagrams of both the shifting and the stationary link teach us still more; upon careful examination it may be ascertained that the motion of the valve in its relation to that of the crank always corresponds to that yielded by a single eccentric whose radius is measured from the centre of the crank, to a certain point lying upon the straight line which joins the points 1, Fig. 2 (plate 235), of the real eccentric and of the fictitious one supposed to be applied to the middle of the link, and the angle of which, with the crank, is defined by the line drawn from the centre of the crank to that certain point; the points 1 it should be stated, indicate the positions of the eccentrics (real and fictitious), when the crank is at the end of its stroke. Such being the case, it is always possible to define the relative motions of the crank and of the valve, as due to any intermediate point of the link, when the diagram of the various positions assumed by the latter during one revolution of the crank is set out, and may be accomplished in the following manner:—with half the distance a_1 b_1 (Fig. 2, plate 235) draw the path of the fictitious eccentric, supposed to be applied to the middle of the link; the diagram itself indicates that it is placed exactly opposite the crank, its point 1 is, therefore, upon the diameter passing through the two extreme positions of the crank and the straight lines 1, 1 may at once be drawn; if now it is desired to define the position of the eccentric to which the motion of the valve, as derived from that *a*, *b* of the link may be referred, with one-half the distance *a*, *b* draw the path of this new fictitious eccentric and from its point of intersection, *d*, with the line 1—1 draw the radius *d o*, which will define the angle of this eccentric with the crank; a similar construction would answer for any other intermediate point of the link. These various considerations may be perhaps of little practical value, but looked upon from a purely abstract point of view, they are not without considerable interest.

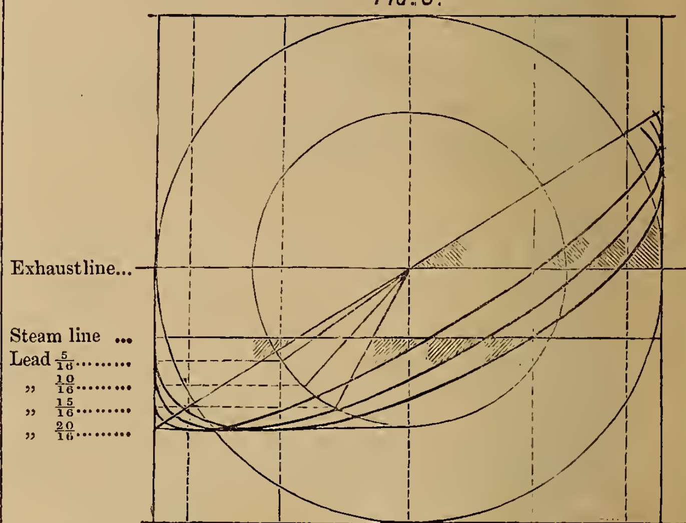
We have stated, previously, that the angle of the eccentric is defined by the sum of lap and lead measured horizontally from the centre of the crank, and we have stated also that the smallest motion of the valve is equal to twice the sum of lap and lead, two statements from which it might be reasonably inferred that the smallest motion of the valve is equal to twice the linear advance of the eccentric; such would be the case if the length of the eccentric rods remained unchanged during the whole period of one revolution of the crank, but as this length is materially affected by the obliquity of the rods, as illustrated by the adjoining sketch (Fig. 7.), it follows that the smallest motion of the valve

FIG. 7



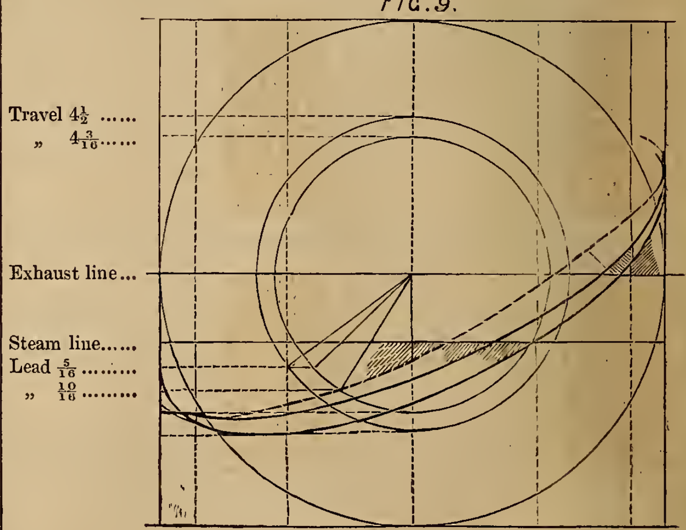
is equal to twice the linear advance of the eccentrics, augmented by twice the maximum difference of length of the eccentric rods occasioned by their obliquity. But as we have seen that in the case of minimum travel of the valve it has reached the end of its stroke when the crank is at the opposite end, since it is evident also that the lap remains unchanged, it is to be inferred that the lead must have increased at each end of the cylinder by the whole amount of the difference of length of the eccentric rods due to their obliquity; this fact is plainly illustrated (Fig. 7.) Where the distances *a c*, *a″ c″* represent the difference of lead which occurs; the same sketch also shows that the lead increases gradually as the link is raised from the position of full gear to that of mid gear, and that the sum of lap and lead in full gear is equal exactly to twice the linear advance of the eccentric as has been stated already. We have adopted this demonstration of the difference of lead, because by it the fact necessarily forces itself upon the reader's mind that in order to avoid great variations of lead it is essential to have very long eccentric rods. This variation in the lead has been a great grievance against the shifting link, and the advocates of other systems have not failed to make the most of this apparent defect; even Mr. Clark himself, who in other respects seems to have been animated by a most unbiassed spirit throughout his work, has taken for the normal pattern of his link motion the stationary box link, evidently on account of its fulfilling the condition of constant lead; for, in speaking of the range of variable expansion by means of the link he says that "a condition necessary to its most successful operation, is the preservation of constant lead for all degrees of expansion;" and yet in the chapter

FIG. 8.



immediately preceding he demonstrates that variable expansion may be obtained, to a considerable extent, by the increase of lead, with constant lap or travel, a fact which is illustrated by the annexed diagram (Fig. 8) taken from his work. He also demonstrates, conclusively, that when lap, lead, and travel increase at the same time, in equal proportions, the events of the distribution remain unchanged, and since it has been shown that the effects of variation of lead and variation of travel are similar,

FIG. 9.



though not quite identical, it follows that increase of lead with decrease of travel must be favourable to the expansive action of the steam; this may be seen from the annexed (Fig. 9), where the dotted line indicates the

motion of the valve with reduced travel and with the lead doubled, whereas the full line indicates the motion of the valve with reduced travel simply.

The only objection that we can see to the increase of lead is the corresponding increase in the period of admission of steam before the piston has reached the end of the stroke; but when it is remembered that the link is used in those of its points yielding long expansions, when the engine is running at great speeds, that is, when the reciprocations of the parts in motion are more frequent and more violent, it may be inferred, with reason, that this increased pre-admission of the steam is a circumstance rather favourable to the preservation of those parts, and, consequently, that the slight increase of lead, far from being a defect, is a decided advantage; it should be remarked, besides, that the engine never can be worked from mid gear, and that the increase of lead is more rapid towards mid gear than towards full gear, both which circumstances militate in favour of the opinion which we have just expressed.

We have stated that the positions of the points of connection with the eccentric rods and of the point of suspension have a material effect upon the events of the distribntion; and, we believe, that for the knowledge which we possess on this subject, we are chiefly indebted to the experimental researches of Mr. Gooch of the Great Western Railway. It is true that local, or individual causes, often lead to peculiar modes of connection and suspension, not quite conformable with the requirements of correct distribution of the steam, notwithstanding this, however, it may prove both interesting and useful to be acquainted beforehand with the results obtained hy various arrangements adopted in practice, and we, therefore, reproduce some of them from Mr. Clark's work in the table below:

TABLE OF DISTRIBUTION, WITH VARIOUS ARRANGEMENTS OF THE SHIFTING LINK, CORRECTED FOR A SIX LENGTHS ROD.

Arrangement of Link.		Admission per cent of stroke. Front.	Back.	Arrangement of Link.		Admission per cent of stroke. Front.	Back.
	Full gear	79	72		Full gear	78	72
	Half gear	51¼	41¾		Half gear	48¼	45¾
	Mid gear	17	15½		Mid gear	17	15½
	Full gear	78	65½		Full gear	77¼	66½
	Half gear	52¾	37		Half gear	51¼	39½
	Mid gear	22¾	12½		Mid gear	21½	12
	Full gear	74	73		Full gear	78	77¼
	Half gear	47	47¾		Half gear	52¼	52
	Mid gear	18½	16¼		Mid gear	19½	20

This table shows how great is the influence arising from the mode of arranging the links, upon the distribution of the steam, a fact which, in badly arranged motions, is very audible when the engine is on duty from the inequality of the beat, or, in other words, from the inequality in the periods of release of the steam at each end of the cylinder; this evil is sometimes remedied by providing unequal lap at the opposite ends of the valve, but it is quite evident that this is not the legitimate mode of correction, since by pure accident the valve may just be put the reverse way into its place; sometimes also the correction is made hy a difference in the width of the steam ports and to this we can see no practical objection.

Fig. 1 (plate 234) is a diagram of the valve motion of the "Lady of the Lake," taken from a fnll size model, and in the following table we give the numerical results, corrected for a seven lengths rod, which, compared with those taken from the engine itself, placed in juxtaposition with them show what a great influence a slight difference in the position of the centres may have; in this case there is a great probability that the model was not fitted up with the same accuracy as the motion itself whose results may, indeed, be said to be practically correct:

ABSTRACT OF RESULTS OF VALVE MOTION OF ENGINE "LADY OF THE LAKE."

	Taken from Diagram.				Taken from Engine.			
	Steam cut off.		Exhaust begins.		Steam cut off.		Exhaust begins.	
	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.
Full gear ...	69½	65¾	85½	88	72½	68½	90	87
Half gear ...	51½	54¾	81¼	81½	50	49	80	77
Quarter gear.	22	27½	66	61	25	23½	62	60

We have stated, in an earlier part of this paper, that the choice in the kind of the link, and the general arrangement of the link motion is, sometimes, subject to considerations of local necessity, a statement which will be very easily understood when it is mentioned that the greatest available space to hold the cylinders never exceeds 4ft. 1½in. upon the narrow gauge (the inside cylinder engine, of course, is here alluded to), which, for cylinders of large dimensions, scarcely leaves room for the link motion. This fact, indeed, was one of the great grievances against the narrow gauge during that memorable episode in the history of railway engineering, known as the "battle of the guages, and in it the advocates of the broad gauge found, undoubtedly, a good argument at that time, for, we helieve that no cylinder, exceeding 16in. in diameter, was then to be found on the narrow guage, while the broad guage could boast of the *Great Britain* with cylinders 18in. diameter. So far as we are able to ascertain the problem of finding room for a commodious arrangement of the link motion, with 18in. cylinders. lodged in the narrow space of 4ft. was first solved by Messrs. Sharp, Stewart and Co., in the "Sphynx," 1847, and as we have every reason to believe that at the time it was a triumph of perseverance and skill in locomotive engineering, we give a section through the cylinders of that engine (Plate 235, Fig. 3), and an illustration of the link motion (Figs. 4 and 5, Plate 235) with a diagram of the motion of the valve (in Figs. 2, 3, 4, Plate 234), Fig. 2 showing the periods of the front stroke; and Fig. 3 those of the back stroke. Here the increase of the lead, amounting to ¼in., is somewhat considerable, but it arises from the fact of the link being very long, and this latter circumstance has the advantage of yielding long periods of admission in full gear; in other respects the results of this motion are very good indeed, the periods of admission corrected for a six lengths rod being as follows:—

	Per cent. of Admission.	
	Front.	Back.
Full gear	83¾	81
Half gear	54	50
Quarter gear	27¼	25

Since that date, however, it has been found possible to put the valves

into their usual place between the cylinders and to cram the link motion into the very narrow space available in the case of 18in. cylinders; but we venture to affirm that such arrangements are anything but an improvement upon the one here illustrated, because they leave no room for repairing the valve faces and invariably lead to awkward and unmechanical modes of connection between the several parts of which the link motion consists, nor admit of those dimensions which provide the amount of wearing surface, so essential to ensure a long continued efficient working of the motion.

The stationary link may be generally illustrated by Fig. 2 (Plate 236), representing the link motion of Mr. J. V. Gooch's engine "Snake;" and upon the same plate (Fig. 1), we have illustrated the motion diagram of a stationary link as fitted to some engines lately constructed for the Great Eastern Railway by Messrs. Fairbairn, and which we are enabled to furnish to our readers through the kindness of Mr. Sinclair. It differs from the shifting link in that it is suspended from a fixed point, and where it is used the act of reversing or of altering the rate of expansion is performed by raising or lowering the valve rod. The link is curved to a radius equal to the length of that rod and has its concave side turned towards the cylinder, by which arrangement the condition of constant lead is effectually realised. The nature of the motion yielded by the stationary link is identical with that yielded by the shifting link, and all that has been said on this subject applies to the three types of link motions. With the stationary link, however, the linear advance of eccentrics is not equal exactly to the sum of lap and lead, for since the position of the link referred to the centre of motion of the valve remains unchanged, it is evident that the effect of the obliquity of the eccentric rods is transmitted to the valve in an equal degree by all the points of the link from full gear to mid gear, and consequently the linear advanee of the eccentrics must be less than the sum of lap and lead by the full amount of the variation of length of the eccentric rods occasioned by their obliquity. From the remarks which we have made, when discussing the peculiarities of the shifting link, we would by no means be understood to detract from any of the real merits of the stationary link, which, in our opinion, however, may simply be stated as follows. The reversing gear required by the use of it is less heavy and compendious, requiring but very small, or no balance weights, and, proportionately also is the labour of reversing made easier; but in opposition to this it is argued that the obliquity taken by the valve rod occasions great vertical pressure upon the glands of the valve spindle, and wears them out very soon, and be it prejudice, or be it a well grounded cause for rejection, certain it is that the stationary link is patronized only by Mr. Gooch, and by Mr. Sinclair.

The straight link may be generally illustrated by Fig. 3 (plate 236); it consists of a reversing shaft having two short levers forged upon it, and placed on opposite sides of the shaft, to one of which the motion link is suspended, and to the other the valve rod. The lever to which the motion link and the eccentric rods are suspended, is made shorter than the one which carries the rod, and this being lighter than the former is thus made to counterbalance them. As a result of this arrangement, in which, during reversal the motion link and the eccentric rod ends are lowered while the valve rod and the motion block are raised, a straight link has to be used, because the versed line of the arc which one portion of the gearing describes, is counteracted by that described by the opposite portion. This construction of the link motion carries along with it several important and undisputable advantages; in the first place, the working surfaces of the straight link are much easier got up and kept in repair; secondly, as the length of the suspending levers seldom exceeds 4 inches, and as the spaces through which the respective parts of the motion have to travel, are very small, a much greater purchase can be obtained with the reversing lever than in the other types of link motions and the labour of reversing, or of altering the degree of expansion is considerably easier, a feature of the utmost importance in cases of emergeney; and lastly, another great advantage is, that much less vertical space is required, in consequenee of which, the boiler can be kept proportionately lower, the differenee amounting often to three or four inches; it may be stated also that it keeps the lead equal for all degrees of expansion. Fig. 4, plate 236, illustrates the motion of a valve having $1\frac{1}{4}$in. lap, the period of the front stroke being indicated by the full lines, and those of the back stroke by the dotted lines, and corrected for the obliquity of the connecting rod, they would be almost equal. In the table below we give the results obtained with a valve having $\frac{7}{8}$ in lap, the ports being so arranged as to have $\frac{1}{4}$in lead to the front, and $\frac{5}{16}$ to the back.

Since in this motion the lead remains unaltered as previouely stated, it follows that the linear advance of the eccentrics is equal to the sum of lap and lead diminished by the whole amount of the difference of length of the eccentric rods occasioned by their obliquity. Some engineers object to this arrangement of link motion on the ground of its causing the glands of the valve spindle to wear out very soon, by reason of the obliquity of the valve rod; we believe, however, that in this case, the objection is without foundation,

Results of Straight Link Motion in per cent of Stroke.

	Suppression.		Release.		Compression.	
	Front.	Back.	Front.	Back.	Front.	Back.
Full gear	72	72	90	90	10	10
4th notch...............	60	60	85	85	15	15
3rd "	50	50	81	80	19	20
2nd "	37	38	74	72	26	28
1st "	23	25	64	62	36	38
Mid gear	14	15	51	49	49	51

We shall not follow the example set by Mr. Clark, to give rules, or prescribe methods for setting out link motions, for we have occasion to know from our own observations that every engineer or every draughtsman finds out a method best suited to himself; all that can be said in the shape of advice on this subject, is as follows: In the case of the shifting link, the reversing shaft and levers should be so placed as to cause the working point of the link in its various positions to move in the straight link, passing though the centre of motion of the valve; in the case of the stationary link the reversing shaft should be so placed as to cause the motion block in all its positions to move in a line parallel to that passing through the centre of motion of the valve; in the case of the straight link, when once its position is decided upon, it may be said that the position of the reversing shaft is given, and the only care to be taken is to have the suspension rods as long as possible, in order to reduce their arcs of vibration as near as possible to a stright line. As for the position of the eccentrics upon the axle, that is generally determined by actual trial underneath the engine, when the link motion complete is in its place, and is afterwards fixed by template for every engine of the same description. Some foremen erectors, however, have sufficient confidence to define that position upon paper, and to set the eccentrics permanently without previous trial. Mr. Clark gives some trigonometrical rules and formulæ to define their position, as well as that of the periods of suppression and release in terms of the stroke; such rules, however, have no practical value whatever, for we can confidently affirm that no practical engineer ever yet set to work in search of any of those quantities with a table of natural sines in his hands, and since in abstract science they teach nothing, we look upon them as being only so much waste paper.

In order to complete our review and study of link motions, we have yet to lay before our readers the apparatus by means of which the engine is reversed, or the rate of admission altered to suit the continually changing wants of the train upon the road.

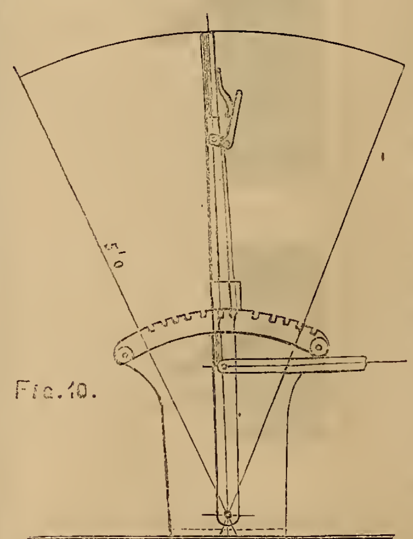


Fig. 10.

The apparatus which, until lately, has been in almost exclusive use, may be generally illustrated by the accompanying woodcut, Fig. 10, and consists of a quadrant or sector notched upon its outer circumference; of a lever or handle pivoting upon a fixed centre as a fulcrum, and carrying the reversing rod at a suitable distance from this fulcrum in such manner as to have sufficient leverage to enable one man easily to overcome the combined resistances of all the parts of the link motion; a guide plate notched like the sector is fixed upon the latter, and the reversing handle in its angular motion slides between them; the handle carries a catch provided with a trigger to be worked with the hand during the act of reversing. The whole system is generally so arranged that the handle stands upright when the link is in mid gear, — that it leans forward *towards* the engine

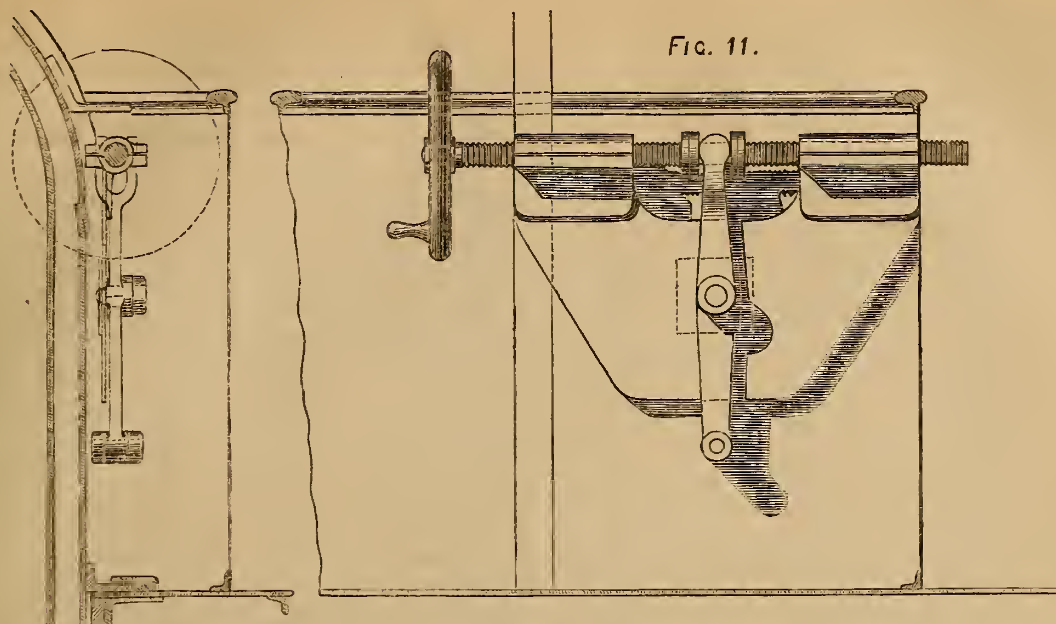


FIG. 11.

when the motion is in forward gear, and backward *from* the engine when it is in backward gear.

Mr. Ramsbottom has adopted, and has used for some time, the scheme illustrated by Fig. 11, and consisting as before, of a lever pivoting upon a fulcrum, and carrying the reversing rod at a suitable distance from that fulcrum, but here the lever is forked at one extremity, and made to engage between the collars projecting upon a screw shaft moving in the two nuts *n n*; the screw is three threaded and is set in motion through a hand-wheel *h*, pushing the lever either forward or backward according as the wheel is turned to the right or to the left. The peculiar advantage of this reversing apparatus is, that it can be worked with much greater ease than the one previously described, and what is of still greater importance, it can never permit the link, of its own accord, to change its position, say from mid gear to full gear, or from backward to forward gear, a circumstance of frequent occurrence when the catch is bad, and which has been the cause of many serious accidents.

(*To be continued.*)

USEFUL NOTES AND FORMULÆ FOR ENGINEERS.

(*Continued from page* 31.)

TABLE I.

LEAST DIAMETERS OF WROUGHT IRON MAINSHAFTS FOR PRIME MOVERS.

H.P. of Prime Mover.	Number of Revolutions of Shaft per Minute.									
	15	20	25	30	35	40	45	50	55	60
3	4·00	3·63	3·34	3·16	3·00	2·88	2·76	2·66	2·60	2·50
5	4·74	4·30	4·00	3·76	3·56	3·46	3·28	3·18	3·06	2·98
8	5·44	5·04	4·66	4·40	4·18	4·00	3·88	3·70	3·58	3·48
10	5·70	5·42	5·04	4·74	4·50	4·30	4·14	4·00	3·86	3·76
12	6·34	5·76	5·28	5·02	4·78	4·56	4·40	4·24	4·10	4·00
14	6·68	6·06	5·64	5·30	5·02	4·80	4·62	4·46	4·32	4·20
16	6·98	6·34	5·88	5·54	5·26	5·02	4·84	4·66	4·52	4·40
18	7·26	6·60	6·12	5·76	5·48	5·24	5·02	4·86	4·70	4·56
20	7·52	6·82	6·34	5·96	5·66	5·42	5·22	5·02	4·88	4·74
25	8·10	7·36	6·82	6·64	6·10	5·84	5·62	5·12	5·25	5·10
30	8·60	7·82	7·26	6·82	6·48	6·20	5·96	5·76	5·58	5·42
35	9·06	8·24	7·64	7·20	6·82	6·54	6·28	6·06	5·88	5·70
40	9·48	8·60	8·00	7·52	7·14	6·82	6·56	6·34	6·14	5·96
45	9·96	8·96	8·32	7·82	7·42	7·10	6·82	6·60	6·38	6·20
50	10·20	9·28	8·60	8·10	7·70	7·36	7·08	6·82	6·62	6·42
55	10·54	9·58	8·88	8·36	7·94	7·60	7·30	7·06	6·82	6·64
60	10·84	9·86	9·14	8·60	8·18	7·82	7·52	7·26	7·04	6·82
65	11·14	10·02	9·40	8·84	8·40	8·04	7·72	7·40	7·22	7·02
70	11·42	10·32	9·64	9·06	8·60	8·24	7·92	7·64	7·40	7·20
75	11·68	10·61	9·86	9·28	8·80	8·42	8·10	7·82	7·58	7·36
80	11·94	10·84	10·06	9·48	9·00	8·60	8·28	8·00	7·74	7·52
85	12·18	11·09	10·18	9·66	9·10	8·70	8·40	8·10	7·90	7·60
90	12·40	11·30	10·40	10·00	9·30	8·90	8·60	8·30	8·00	7·70
95	12·60	11·50	10·60	10·10	9·50	9·10	8·70	8·40	8·20	7·90
100	12·80	11·70	10·80	10·10	9·80	9·20	8·90	8·60	8·30	8·10

TABLE II.

ULTIMATE STRENGTH OF PILLARS CAST FROM LOW MOOR IRON, IN POUNDS AVERDUPOIS PER SQUARE INCH OF SECTIONAL AREA.

Length ÷ Diameter.	Solid Columns.	Hollow Columns.
80	4,000	—
78	4,000	—
76	4,000	—
74	4,100	—
72	4,500	—
70	4,750	—
68	5,000	—
66	5,400	—
64	5,900	—
62	6,200	—
60	6,900	—
58	7,300	—
56	8,000	—
54	8,600	—
52	9,500	12,000
50	10,500	13,000
48	11,500	14,000
46	12,500	15,000
44	14,000	16,700
42	15,000	18,000
40	16,800	20,000
38	18,500	22,100
36	20,000	24,500
34	22,000	27,000
32	24,500	30,000
30	27,000	33,000
28	29,500	35,500
26	32,000	38,000
24	35,000	41,500
22	38,000	45,500
20	41,000	50,000

TABLE III.

Strain on Chains and Arches.

$\frac{c}{v}$	At Centre.	At Support.	Length of Curve.
50	W.6·250	W.6·270	*v.* 50·04
45	5·625	5·650	45·04
40	5·000	5·025	40·06
35	4·375	4·403	35·06
30	3·750	3·783	30·10
25	3·122	3·163	25·10
20	2·500	2·549	20·12
19	2·375	2·423	19·14
18	2·250	2·305	18·14
17	2·125	2·181	17·15
16	2·000	2·062	16·16
15	1·875	1·913	15·17
14	1·750	1·820	14·18
13	1·625	1·695	13·20
12	1·500	1·581	12·21
11	1·375	4·468	11·23
10	1·250	1·345	10·26
9	I·125	1·230	9·29
8	1·070	1·120	8·32

c = chord of arc or span.
v = versine or deflection.
W = total load on chain or arch.

Rule.—Find the value of $\frac{c}{v}$ in first column; the number opposite it in the second column × W = strain at centre; the number on the same line in the third column × W = strain on chain or arch at either point of support; the number in the fourth column × the versine = the length of the arc.

TABLE IV.

Co-efficients of Friction and Angles of Repose.

Name of Material.	Co-efficient of Friction = tan. ϕ.	Angle of Repose = ϕ
Dry Masonry and Brickwork	0·60 to 0·70	$31\frac{1}{2}°$ to $35°$
Masonry and Brickwork with damp Mortar	0·74	$36\frac{1}{2}°$
Timber on Stone..........................	0·40	22°
Iron on Stone	0·70 to 0·30	$35°$ to $16\frac{2}{3}°$
Timber on Timber	0·50 to 0·20	$26\frac{1}{2}°$ to $11\frac{1}{3}°$
Timber on Metals	0·60 to 0·20	$31°$ to $11\frac{1}{2}°$
Metals on Metals	0·25 to 0·15	$14°$ to $8\frac{1}{2}°$
Masonry on dry Clay....................	0·51	27°
Masonry on moist Clay..............	0·33	$18\frac{1}{4}°$
Earth on Earth	0·25 to 1·00	14° to 45°
Earth on Earth, dry Sand, Clay, and mixed Earth	0·38 to 0·75	21° to 37°
Earth on Earth, damp Clay	1·00	45°
Earth on Earth, wet Clay...........	0·31	17°
Earth on Earth, Shingle, & Gravel	0·81 to 1·11	29° to 48°

TABLE V.

The ultimate Strength of Materials used in Construction.

The breaking weights are stated in lbs. avoidupois, per square inch of sectional area.

Name of Material.	Tension.	Compression.	Shearing.	Modulus of Elasticity.
Ash	17,207	9,000	....	1,600,000
Brass, Cast	17,968	10,300	....	9,170,000
Brick..................	280	807	....	....
Copper, Cast.........	19,072	....	....	....
—— Wire	61,228	....	....	17,000,000
—— Bolts	48,000	....	....	....
Deal, Christ.	12,400	....	....	1,672,000
Fir, Riga	11,549	6,000	....	1,130,000
Hornbeam	20,240	7,289	....	....
Iron, Wrought.				
—— Bar	60,000	36,000 to 40,000	·50,000	29,000,000
—— Russlan	60,000		....	....
—— Swedish	71,000		....	....
—— Sheet	50,000		....	....
—— Chain	52,460		....	....
Iron, Cast.				
Hematite, No. 1 ...	14,233	52,136	18,915	7,541,000
—— 2 ...	17,751	82,265	20,455	10,455,000
—— 4 ...	17,566	82,583	24,335	10,145,000
Weardale, No. 1 ...	18,080	52,771	27,558	9,911,000
—— 3 ...	21,859	90,046	28,520	10,830,000
—— 4 ...	23,513	109,286	31,050	12,375,000
Southbank	18,425	86,886	32,285	12,375,000
Stockton, No. 1 ...	25,810	99,524	28,715	13,315,000
—— 3 ...	22,271	87,063	30,810	12,265,000
Butterley, No. 1 ...	23,388	88,488	35,870	12,200,000
—— 2 ...	18,970	74,743	29,315	11,591,000
—— 3 ...	23,265	91,661	33,900	12,020,000
Ilkeston, No. 1......	22,107	82,229	30,585	10,815,000
—— 2......	29,840	119,483	39,655	13,012,000
—— 3......	30,115	120,321	38,960	13,993,000
—— 4......	19,847	75,318	37,660	12,245,000
Goldendale	25,430	113,459	33,430	12,943,000
Netherton, No. 1...	20,517	73,977	29,960	10,350,000
—— 2...	26,012	86,473	35,145	11,165,000
—— 4 & 5...	30,344	108,285	36,960	12,945,000
Parkhead	27,033	95,787	29,835	12,080,000
Old Hill, No. 2 ...	14,593	50,499	22,705	9,737,300
—— 3 ...	23,815	80,991	34,918	12,022,000
—— 4 ...	22,918	80,213	28,112	12,075,000
Lays Works.........	31,480	119,631	24,800	12,135,000
Parkend	17,019	56,116	21,878	8,680,500
Blænavon, No. 1 ...	26,766	91,897	26,820	12,017,000
—— 3 ...	23,903	87,358	27,750	11,795,000
Pontypool...........	26,302	99,618	25,535	11,735,000
Larch	10,220	5,568	1,300	879,600
Oak, English	17,300	9,509	2,300	1,451,200
—— Canada.........	10,250	9,509	....	2,148,800
—— Dantzic	12,780	....	....	1,191,200
Pine, Pitch	7,818	6,790	....	1,225,600
—— Red	....	5,375	650	1,840,000
—— Yellow.........	....	5,445	....	1,600,000
Steel	110,000 to 130,000	....	....	29,000,000 to 42,000,000

ARE GAS HOLDERS LIABLE TO EXPLOSION?

By T. W. Keates, F.C.S.

During the progress of a recent conflagration which occurred in the immediate neighbourhood of one of the largest of the metropolitan gas works, considerable excitement and alarm were experienced by many of those living in the adjoining streets, or present in the crowd, from the idea that if the fire extended to the gas holders, which at the time were filled with the gas required for the supply of the public and private lights, an explosion of unexampled force and destructiveness would be the result. It was stated that many persons hastened away from the locality when they heard that there was a probability of the flames reaching the gas works; some thinking that if an explosion occurred, even the dome of St. Paul's might be endangered; others that at least Blackfriars Bridge would be destroyed; and, indeed, the public mind was filled at the moment with that vague and unreasoning sense of danger, which, operating upon great masses of people, effectually prepares the way for the most dangerous panic.

It is very desirable, both in the interest of the gas companies and of the public, that the erroneous ideas which gave rise to these really absurd, although in some respects natural, fears, should be corrected. There is but one way in which this can be done, that is, by affording information concerning the agents and forces involved in the question; so that a clearer conception of their nature may be acquired, and the undefined terrors, which in this, as in other similar cases, are engendered and fostered by ignorance, may be removed by a rational consideration of the physical and chemical laws to which such agents are subject. In accordance with this view, there are, then, to be considered—first, the character of coal gas with reference to the question of explosion; secondly, whether explosive mixtures of coal gas can be produced by circumstances attendant upon a fire extending itself to the gas holders. With regard to the first part of the inquiry, it must be remembered that the gaseous mixture, which we know as coal gas, is not *per se* an explosive, although it is an eminently combustible, material. When ignited, it burns with the greatest rapidity, evolving an immense flame, and producing a very great amount of heat; but there is no more tendency to explosion than when coals, or any other combustible substance, are burning in a furnace. Certain constituents of coal gas require a very high temperature to inflame them; others are readily inflamed at a red heat; but the lowest point at which any one of its constituents may be inflamed must be taken as the index of the point of inflammation of the mixture, and this may be, perhaps, set at a red heat. When coal gas burns in the air, it is, of course, at the expense of the atmospheric oxygen, the process simply consisting in the oxidation of the carbon and hydrogen of the gas; and this action is necessarily confined to the exposed surface. Under such circumstances, the oxidation goes on gradually, and a certain time is required to bring in contact the combustile atoms and the oxygen; we have then burning, but no explosion. To effect complete oxidation, coal gas consumes, or rather combines with, about two and a half times its bulk of oxygen, which are equal to more than twelve times its bulk of atmospheric air. If, however, the required quantity of oxygen, or of air containing the oxygen, be mixed with coal gas before the latter is inflamed, and means of inflaming the gas be then applied, combustion will not progress gradually, as it does when the gas alone is inflamed, but will occur atomically as it were,—that is, each atom of gas finding in its immediate proximity an atom of oxygen, the union between the two will take place throughout the whole volume of the gaseous mixture instantaneously, and a violent explosion will be the result. To produce this explosion, oxygen, in certain proportion, must be mixed with the gas before ignition. In the absence of oxygen, previously so mixed, there can be no explosion.

Sir H. Davy, in his important and interesting experiments upon this subject, found that light carburretted hydrogen, the most powerfully explosive of the gases, required about seven times its bulk of atmospheric air to be mixed with it to produce the greatest explosive effect; practically, it may be calculated that from eight to nine times its bulk of air will produce the most explosive mixture with coal gas: but, as was remarked before, the air and gas must be mixed previously to inflammation. No matter how rapidly the air may be supplied when the gas is burning, it will merely increase the fierceness of the combustion: there will be no explosion. To form an explosive mixture the gas must be present in quantity varying from about 7 to 25 per cent. of volume; if it fall short of or exceed that proportion, it will burn away quietly, and not explode. So it will be perceived that, in the contents of the gas holders, we have to deal with a material which is combustible in the highest degree, but which in itself, even when burning, has no tendency to explode, and which cannot be made to explode excepting by changing its normal state by previous admixture with a foreign gas, viz., oxygen.

There is another property of coal gas which relates to this inquiry, and which it possesses in common with all matter,—that is, expansibility under increased temperature. When a gas is heated, its volume is augmented. For every degree of Fahrenheit's thermometer this augmentation equals $\frac{1}{480}$th part of the bulk of the gas at 32°, so that the volume of a gas being 480 cubic inches at 32°, it would be 481 at 33°, 482 at 34°, and so on. The qualities of coal gas, then, which relate to the question of explosion of gas holders are—combustibility, capability of forming explosive mixtures with oxygen gas or air, and susceptibility of having its bulk or volume increased by rise of temperature. It remains to see how far circumstances arising from the application of heat or flame to the exterior of a gas holder could so affect or modify its contents as to produce explosion, as many persons have seen cause to dread. In the gas holder itself we have an apparatus very well calculated to preserve the gas which it contains from any admixture with the external atmosphere; and, indeed, under all ordinary circumstances, such admixture is impossible. It must be remembered, that the gas holder, formed of strong plate iron, is so arranged that it is only capable of moving vertically, under the guidance of firmly constructed iron rods and pillars, and that, during all its movements, its lower edge remains immersed in a tank of water; were it not so its contents could not be preserved at all, as it must be remembered that gas holders *rise* in consequence of the elastic raising force of the gas which is forced into them, and are not *suspended*. The moment the gas is removed by any means from the holder the latter sinks by virtue of its weight, which operates as a powerful expulsive force, and is, in fact, the only force which sends the gas through the almost endless ramifications of pipes by which it is distributed for public consumption. Are there, then, any conditions in which the gas in the holder could become mixed with a sufficient quantity of air to be rendered explosive; those conditions, of course, being produced by the action of heat applied externally to the holder?

Some years since it happened, at one of the London gas works, that a portion of the upper part of the heavy iron framework which guides the holder became detached, and, falling upon the top or crown of the holder, crashed through, making a large hole in the iron plate. The weight of the holder caused the gas to rush through this opening with great velocity; reaching a light which was burning near, it became ignited, and, as may be supposed, a flame of immense size and force—a sort of gigantic blow-pipe flame—was produced; as the aperture was of considerable size, the whole of the gas was, however, expelled from the holder in a very short time, and no damage was done,—nothing in the remotest degree resembling explosion having occurred. Suppose, during a great fire at a gas works, that, by any means, a gas holder became perforated, the only result would be that just described; and even if the perforation were made in a part of the holder from which the flame might prove a means of extending the conflagration, there would be no danger of explosion, unless, as we have seen before, the gas holder contained a mixture of gas and atmospheric air or oxygen. Is there, then, any probability of such an explosive mixture being produced in a gas holder through the effect of an external fire?

If a gas holder, filled with gas, were exposed to the action of violent flame, it is evident that, in accordance with the law of expansion already explained, the volume of the gas would be rapidly increased. It is scarcely in the nature of things that a large gas holder should be uniformly heated on every side; but, for the sake of illustration, let it be supposed that the whole mass of the gas was raised to 1000°, a very high temperature, about equal to bright-red heat; under these circumstances, the volume of the gas would be nearly tripled, so that from a gas holder capable of containing 3000 cubic feet, nearly two-thirds of the contents would be expelled by mere expansion,—that is, if the holder were at first filled to its full capacity. As the holder cannot rise out of the water of the tank, owing to the iron framework by which it is held, the excess of gas—that is, 2000 cubic feet—would be forced under the edge of the holder, and would bubble up through the water, a thing which not uncommonly happens on a limited scale in gas works when the holders are over-filled: as the gas thus escaped, it would, of course, inflame, and a succession of irregular fierce combustions, so to speak, would be the consequence; but, as the gas could not previously have been mixed with air, there would be no explosion. Now, let us suppose the source of heat to be removed, the fire about the gas holder to be subdued, for example, the contained gas would cool, and, in cooling, would contract to its natural density; this being so, it would only be capable of occupying one-third of the capacity of the holder, which would, of course, descend as the contraction progressed, and the result would be, not that any mixture of air and gas had been produced in it, but that the gas holder would be found less elevated from the tank by two-thirds of the height which it reached when first subjected to the action of the heat. Let us, however, take an extreme case, in which the holder, filled with gas, expanded to three times its normal volume, is suddenly cooled, and in which, from the action of the fire, the guides or pulleys of the holder itself have been so deranged that the holder cannot descend upon the contracted gas; it is obvious that the gas, in cooling, will, as in the former case, be only capable of filling one-third of the holder; the water of the tank cannot rise to fill the vacant space; atmospheric air would therefore pass under the edge of the holder, or blow through the water seal; and very shortly the contents of the holder

would consist of about one-third of gas and two-thirds of atmospheric air; even then the mixture would not be explosive. Davy's experiments show that, when the gas present in the mixture exceeds from 20 to 25 per cent., it burns quietly, and does not explode; and in the above case, a most unlikely one to occur, the gas is present in the proportion of 33 per cent. If a gas holder became fixed by any means, in the manner spoken of, and by accident the side of the tank were broken down, so that the water flowed away from the holder, the contained gas would be in communication with the atmospheric air; in that case, however, the mixture of the two would be but a slow operation, as, by its superior levity, the gas would continue to occupy the suspended holder until sufficient time had elapsed for diffusion of the gas and air to take place.

If flame were to be brought into contact with the contents of the gas holder shortly after the occurrence of such an accident, which would, of course, happen if the injury to the tank were caused by fire, there would be still no explosion, but burning of the gas from the surface upwards, as in a common lecture table experiment, where combustible gas, contained in an inverted jar, is ignited at its inferior surface, and extinguishes a lighted taper plunged into its mass. As to the gas holder itself being so much damaged by the action of the heat or flame, as to be rendered incapable of containing the gas, such a thing is scarcely possible. It is well known that rivetted sheet iron vessels will bear a lengthened exposure to a red heat before they are so much injured as to become leaky; and if, in the case of the gas holder, the sudden action of powerful flame, striking on its exterior, were so to twist or warp the plates, that the gas could escape, there would be simply combustion of the gas as it issued from the openings, as in the case of the perforated gas holder first discussed.

A little consideration of this subject seems to show, then, that the explosion of a gas holder, from circumstances created by the influence of a conflagration in a gas works is an event, not perhaps beyond the bounds of possibility, but so far removed from anything like probability, that any serious fears in connection with it must be looked upon as entirely groundless. Such an occurrence seems never to have taken place in the whole course of gas-making practice; and if we reflect upon the natural laws which operate in the matter, it is to be presumed that it could scarcely be made to happen under the influence of any external circumstances. It cannot be denied that a conflagration may be increased to a fearful extent by the contents of a gas holder becoming ignited, but it may be safely questioned if, in any case, there is the slightest danger to be apprehended from explosion.—*Newton's London Journal.*

SCOTTISH SHIPBUILDERS' ASSOCIATION.

THE PRINCIPLES OF THE NEW MEASUREMENT TONNAGE.

By Mr. J. G. Lawrie.

By the "Merchant Shipping Act, 1854," the measurement of ships for tonnage is made by one of the two following rules; and the tonnage so ascertained is deemed the register tonnage in all ships except those propelled by steam:—

"Throughout the following rules the tonnage deck shall be taken to be the upper deck in ships which have less than three decks, and to be the second deck from below in all other ships; and in carrying such rules into effect all measurements shall be taken in feet and fractions of feet; and all fractions of feet shall be expressed in decimals:

"Rule I.—The tonnage of every ship to be registered, with the exceptions mentioned in the next section, shall, previously to her being registered, be ascertained by the following rule, hereinafter called Rule I.; and the tonnage of every ship to which such rule can be applied, whether she is about to be registered or not, shall be ascertained by the same rule.

"(1.) Measure the length of the ship in a straight line along the upper side of the tonnage deck from the inside of the inner plank (average thickness), at the side of the stem to the inside of the midship stern timber or plank there, as the case may be (average thickness), deducting from this length what is due to the rake of the bow in the thickness of the deck, and what is due to the rake of the stern timber in the thickness of the deck, and also what is due to the rake of the stern timber in one-third of the round of the beam; divide the length so taken into the number of equal parts required by the following table, according to the class in such table to which the ship belongs.

"Table.

"Class 1. Ships of which the tonnage deck is, according to the above measurement, 50 feet long or under, into four equal parts:

"Class 2. Ships of which the tonnage deck is, according to the above measurement, above 50 feet long and not exceeding 120, into six equal parts:

"Class 3. Ships of which the tonnage deck is, according to the above measurement, above 120 feet long and not exceeding 180, into eight equal parts:

"Class 4. Ships of which the tonnage deck is, according to the above measurement, above 180 feet long and not exceeding 225, into ten equal parts:

"Class 5. Ships of which the tonnage deck is, according to the above measurement, above 225 feet long, into twelve equal parts.

"(2.) Then, the hold being first sufficiently cleared to admit of the required depths and breadths being properly taken, find the transverse area of such ship at each point of division of the length as follows:—Measure the depth at each point of division, from a point at a distance of one-third of the round of the beam below such deck, or, in case of a break, below a line stretched in continuation thereof, to the upper side of the floor timber at the inside of the limber strake, after deducting the average thickness of the ceiling which is between the bilge planks and limber strake; then, if the depth at the midship division of the length do not exceed sixteen feet, divide each depth into four equal parts; then measure the inside horizontal breadth at each of the three points of division, and also at the upper and lower points of the depth, extending each measurement to the average thickness of that part of the ceiling which is between the points of measurement; number these breadths from above (*i.e.*, numbering the upper breadth one, and so on down to the lowest breadth); multiply the second and fourth by four, and the third by two; add these products together, and to the sum add the first breadth and the fifth; multiply the quantity thus obtained by one-third of the common interval between the breadths, and the product shall be deemed the transverse area; but if the midship depth exceed sixteen feet, divide each depth into six equal parts instead of four, and measure as before directed the horizontal breadths at the five points of division, and also at the upper and lower points of the depth; number them from above as before; multiply the second, fourth, and sixth by four, and the third and fifth by two; add these products together, and to the sum add the first breadth and the seventh; multiply the quantity thus obtained by one-third of the common interval between the breadths, and the product shall be deemed the transverse area.

"(3.) Having thus ascertained the transverse area at each point of division of the length of the ship as required by the above table, proceed to ascertain the register tonnage of the ship in the following manner:—Number the areas successively 1, 2, 3, &c., No. 1 being at the extreme limit of the length at the bow, and the last No. at the extreme limit of the length at the stern; then, whether the length be divided according to the table into four or twelve parts, as in Classes 1 and 5, or any intermediate number as in Classes 2, 3, and 4, multiply the second and every even numbered area by four, and the third and every odd numbered area (except the first and last) by two; add these products together, and to the sum add the first and last if they yield anything; multiply the quantity thus obtained by one-third of the common interval between the areas, and the product will be the cubical contents of the space under the tonnage deck; divide this product by one hundred, and the quotient being the tonnage under the tonnage deck shall be deemed to be the register tonnage of the ship, subject to the additions and deductions hereinafter mentioned.

"(4.) If there be a break, a poop, or any other permanent closed-in space on the upper deck, available for cargo or stores, or for the berthing or accommodation of passengers or crew, the tonnage of such space shall be ascertained as follows:—Measure the internal mean length of such space in feet, and divide it into two equal parts; measure at the middle of its height three inside breadths, namely, one at each end and the other at the middle of the length; then to the sum of the end breadths add four times the middle breadth, and multiply the whole sum by one-third of the common interval between the breadths; the product will give the mean horizontal area of such space; then measure the mean height, and multiply by it the mean horizontal area; divide the product by one hundred, and the quotient shall be deemed to be the tonnage of such space, and shall be added to the tonnage under the tonnage deck, ascertained as aforesaid, subject to the following provisoes: first, that nothing shall be added for a closed-in space solely appropriated to the berthing of the crew, unless such space exceeds one-twentieth of the remaining tonnage of the ship, and in case of such excess the excess only shall be added; and, secondly, that nothing shall be added in respect of any building erected for the shelter of deck passengers, and approved by the Board of Trade.

"(5.) If the ship has a third deck, commonly called a spar deck, the tonnage of the space between it and the tonnage deck shall be ascertained as follows:—Measure in feet the inside length of the space at the middle of its height from the plank at the side of the stem to the lining on the timbers at the stern, and divide the length into the same number of equal parts into which the length of the tonnage deck is divided as above directed; measure (also at the middle of its height) the inside breadth of

the space at each of the points of division, also the breadth of the stem and the breadth at the stern; number them successively 1, 2, 3, &c., commencing at the stem; multiply the second and all the other even numbered breadths by four, and the third and all the other odd numbered breadths (except the first and last) by two; to the sum of these products add the first and last breadths; multiply the whole sum by one-third of the common interval between the breadths, and the result will give in superficial feet the mean horizontal area of such space; measure the mean height of such space, and multiply by it the mean horizontal area, and the product will be the cubical contents of the space; divide this product by one hundred, and the quotient shall be deemed to be the tonnage of such space, and shall be added to the other tonnage of the ship ascertained as aforesaid; and if the ship has more than three decks, the tonnage of each space between decks above the tonnage deck shall be severally ascertained in manner above described, and shall be added to the tonnage of the ship ascertained as aforesaid."

"Ships which, requiring to be measured for any purpose other than registry, have cargo on board, and ships which, requiring to be measured for the purpose of registry, cannot be measured by the rule above given, shall be measured by the following rule, hereinafter called Rule II.:—

"(1.) Measure the length on the upper deck from the outside of the outer plank at the stem to the aftside of the stern-post, deducting therefrom the distance between the aftside of the stern-post and the rabbet of the stern-post at the point where the counter plank crosses it; measure also the greatest breadth of the ship to the outside of the outer planking or wales, and then, having first marked on the outside of the ship on both sides thereof the height of the upper deck at the ship's sides, girt the ship at the greatest breadth in a direction perpendicular to the keel from the height so marked on the outside of the ship on the one side to the height so marked on the other side, by passing a chain under the keel; to half the girth thus taken add half the main breadth; square the sum; multiply the result by the length of the ship taken as aforesaid; then multiply this product by the factor ·0017 (seventeen ten-thousandths) in the case of ships built of wood, and by ·0018 (eighteen ten-thousandths) in the case of ships built of iron, and the product shall be deemed the register tonnage of the ship subject to the additions and deductions hereinafter mentioned.

"(2.) If there be a break, a poop, or other closed-in space on the upper deck, the tonnage of such space shall be ascertained by multiplying together the mean length, breadth, and depth of such space, and dividing the product by 100, and the quotient so obtained shall be deemed to be the tonnage of such space, and shall, subject to the deduction for a closed-in space appropriated to the crew as mentioned in Rule I., be added to the tonnage of the ship ascertained as aforesaid."

In ships propelled by steam an allowance or deduction is made from the tonnage, ascertained by these rules, for the space occupied by or on account of the machinery, and the remainder is deemed the register tonnage. This allowance is measured in the following manner, by an order of the Commissioners of Customs, dated 23d October, 1860:—

"In pursuance of the powers granted by the 29th section of the 'Merchant Shipping Act, 1854,' the Board, with the approval of the Board of Trade, direct, with a view to the more accurate and uniform application of the principle of granting a certain allowance to steamers for their propelling power, that in lieu of the rules set forth in the section 23rd of the 'Merchant Shipping Act,' and in paragraphs 4, 5, 6, 18, and 20, of instructions to measuring surveyors of 1865, the following rule be adopted in future, viz.:—

"*Rule*.—In every ship propelled by steam or other power requiring engine room, an allowance of space or tonnage shall be made for the space occupied by the propelling power, and the amount so allowed shall be deducted from the gross tonnage of the ship, and such deduction shall be estimated as follows (that is to say):—

"(1.) Measure the mean length of the engine room between the foremost and aftermost bulkheads or limits of its length, excluding such parts, if any, as are not actually occupied by or required for the proper working of the machinery; then measure the depth of the ship at the middle point of this length, from the ceiling at the limber strake to the upper deck in ships of three decks and under, and to the third deck, or deck above the tonnage deck, in all other ships; also the inside breadth of the ship, clear of sponsing, if any, at the middle of the depth; multiply together these dimensions of length, breadth, and depth for the cubical contents; divide this product by 100, and the quotient shall be deemed to be the tonnage of the engine room, or allowance to be deducted from the gross tonnage on account of the propelling power.

"(2.) In the case of ships having more than three decks the tonnage of the space or spaces betwixt decks, if any, above the third deck, which are framed in for the machinery or for the admission of light and air, found by multiplying together the length, breadth, and depth thereof, and dividing the product by 100, shall be added to the tonnage of such space.

"(3.) In the case of screw steamers the tonnage of the shaft trunk shall be deemed to form part and added to such space, and shall be ascertained by multiplying together the length, breadth, and depth of the trunk, and dividing the product by 100.

"(4.) In any ship in which the machinery may be fitted in separate compartments the tonnage of each such compartment shall be measured severally in like manner according to the above rules, and the sum of their results shall be deemed to be the tonnage of the said space."

Diagrams 1 and 2, page 60, are explanatory of these rules.

These diagrams represent a ship with two decks, the upper one of which is of a length, measured in the manner pointed out in the rules, greater than 180ft., and less than 225ft., and a depth of hold greater than 16ft. By the rules the length of this ship, from 1 to 11, is divided into 10 equal parts, at the points 2, 3, 4, 5, 6, 7, 8, 9, 10. At each of the points of division, and also at the extremities, 1, 11, of the length, sections are made as in diagram No. 2. These sections being of a length 1 to 7, measured as pointed out in the rules, greater than 16ft., are divided into six equal parts, at the points 2, 3, 4, 5, 6, diagram No. 2. The area of each of these cross-sections (Figs. 5 and 6), is calculated, as pointed out in the rules, by adding together the breadth at one, the breadth at 7, twice the breadth at each of the other odd numbers, and four times the breadth at each even number. The sum of these breadths is multiplied by one-third of the distance betwixt the breadths, and the product is the area of the section. Having obtained in this way the area of the cross-sections at the points 1, 2. . . . 11 of diagram No. 1, the cubical internal capacity of the ship is calculated in the same way as the area of the cross-sections, and as follows:—The area at 1, the area at 11, twice the area at each of the other odd numbers, and four times the area at each even number, are added together; and the sum of the areas so obtained being multiplied by one-third of the distance betwixt the areas, the product is deemed the cubical capacity of the ship. The cubical capacity being divided by 100, the quotient is the tonnage of the ship.

Whether the tonnage of a ship so ascertained gives a correct measurement of the internal capacity, depends plainly upon whether the areas at the points 1, 2, ... 11 of the length are correctly measured in the manner pointed out in the rules, and also upon the use made of these areas in the calculation by which the cubical capacity is evolved.

The areas of the sections are calculated upon the principle that each section is composed of six parts, as shown in diagram No. 6, and that the area of each of these component parts, say of the part A B C D, is obtained by adding the breadths A B, C D, to four times the breadth E F, and multiplying the sum by one-third of the distance from A B to E F.

The theorem upon which this mode depends of calculating an area bounded by the three straight lines A B, D C, A D, and the curved line B C, is correct, if the curved line be of a form which possesses certain known characteristics. If the curved line be of the form called by mathematicians a curve of the second order, or a conic section, the area is, as is shown in the note,* correctly calculated in this way; but if the curved line be of any other form, the area is not correctly measured in that way, and the amount of error depends on the form of the curved line, and on the extent to which it differs from a curve of the second order.

The areas of the several cross-section at the points 1, 2, ... 11, measured in this way, are used in the mode of calculation prescribed by the rules, to form a curve of areas, as in diagram No. 3, in which the perpendiculars at the points 1, 2, ... 11 are drawn of a length proportional to the areas of the sections at these points, and the surface of this curve of areas is assumed to be the internal capacity of the ship. The surface of this curve is calculated in the same way as the surfaces of the various cross-sections are calculated. The widths of the curve at the points 1, 11, twice the width of each of the remaining odd numbered widths, and four times the widths of each of the even numbered widths are added together. The sum is multiplied by one-third of the distance betwixt the cross-sections, and the product is deemed the internal capacity. It is plain that this mode of calculation assumes the curve of areas to

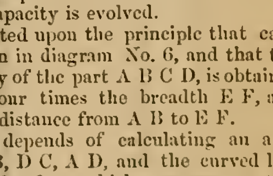
* If B F C be a curve of the second order, its equation is

$$y = A + Bx + Cx^2.$$

resolving this equation with the values a, b, c, h,

$$A = a \quad B = (c - 4h^2 b - a)\frac{1}{2h}$$

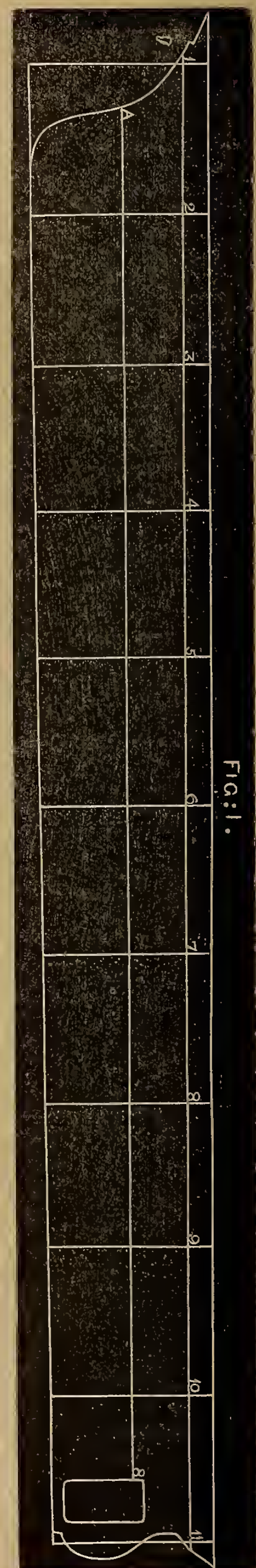
$$C = \frac{c + a - 2b}{2h^2},$$

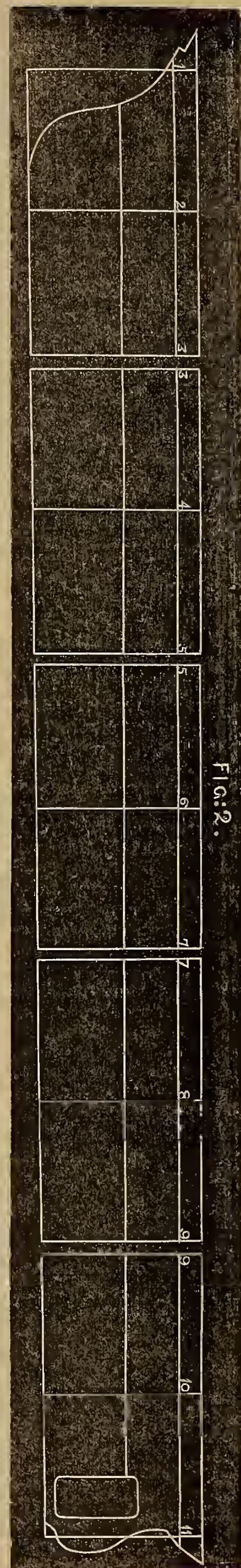


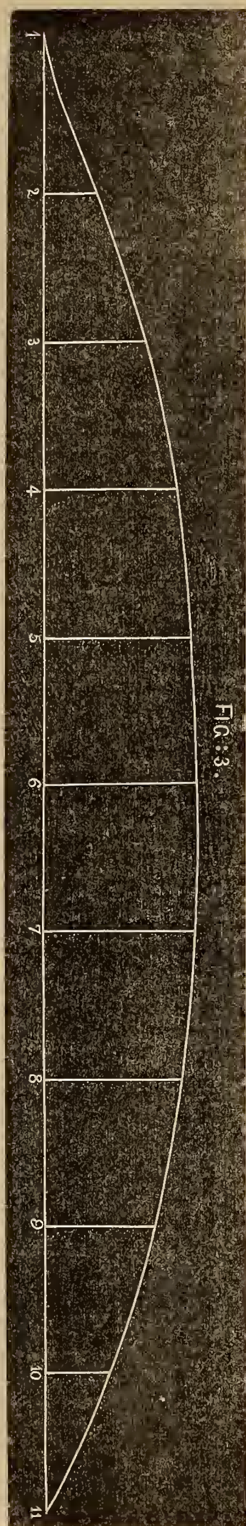
The differential of the area of a curve is $y\,dx$; and therefore the differential of the area of this curve $= y\,dx = A\,dx + Bx\,dx + Cx^2\,dx$.

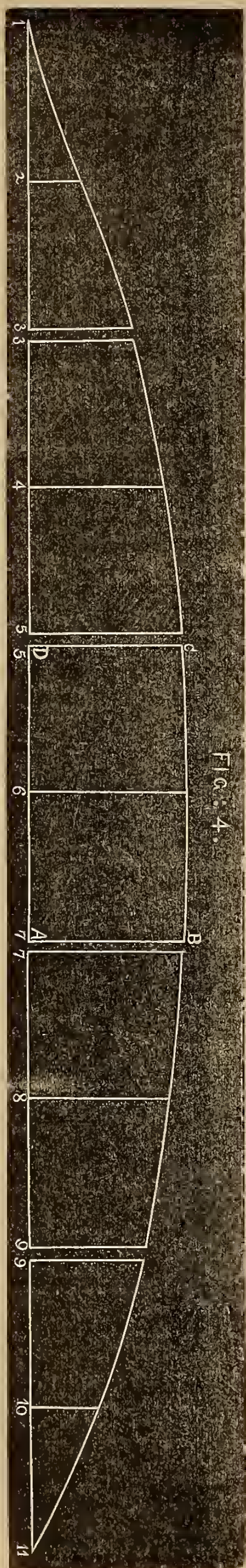
$$\therefore \text{Area of the curve} = \int y\,dx = Ax + \tfrac{1}{2}Bx^2 + \tfrac{1}{3}Cx^3 + C.$$

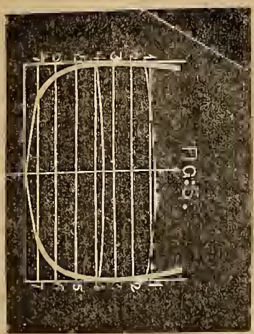
By introducing the values of A, B, C, and putting successively $x = o$ and $x = 2h$, the area from A B to D C is found to be $= (a + c + 4b) \times \frac{1}{3}h$.

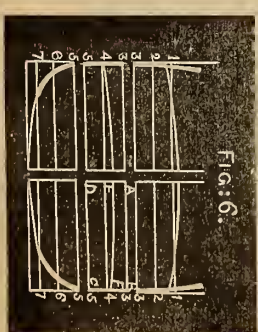












THE PRINCIPLES OF THE NEW MEASUREMENT TONNAGE.

BY MR. J. G. LAWRIE.

consist of five component parts, as in diagram No. 4, and that the surface of each of these component parts, as, for example, A B C D, is obtained by adding the breadths A B, D C to four times the breadth E F, and multiplying the sum by one-third of the distance from A B to E F. As already stated, the accuracy of this mode of ascertaining the surface of the curve of areas depends upon the form of the curved line B C. If this line be a curve of the second order, the measurement is correct; but if it be a line of any other form, the calculation of measurement so made is incorrect, and the amount of error depends upon the form of the line.

It thus appears that the mode prescribed of calculating the internal capacity of a ship is not necessarily exact, unless the ship be of a particular form—unless it be of such a form that the various cross-sections are conic sections, and also that the line called the curve of areas, relating to that ship, be a curve of the second order. There is, besides, an element of inaccuracy in the calculation of the internal capacity of the ship due to the way in which the measurements are directed to be taken. The length from 1 to 11, in diagram No. 1, is plainly greater to a considerable extent than the body of the ship; and in the case of screw steamers, which have a propeller aperture, is greater to an extent of material importance. In consequence of the excessive length taken, the curve of areas in these ships must always be considerably different, and more particularly at the after end of the ship, from the form, consistent with accuracy in the calculations; at the bow, the fore end of the length taken being at 8, the length is greater than the body of the ship by the amount which the point 1 overhangs the various water-lines; and at the stern, the after end of the length taken being at 11, it extends considerably beyond the greater part of the ship, which terminates at the fore side of the propeller aperture. This error in the mode of taking the measurements would be avoided if the length was taken at half the depth of hold, as on the line A B, diagram No. 1, and calculating separately the capacity of those parts of the ship beyond the extremities of this line, A B, in the same way as the tonnage of quarter-decks, poops, and roundhouses is measured.

To measure, however, the tonnage of a ship in a manner which will afford no inducement to the builder or owner to adopt a form of ship unsuitable for the performance of duty was the material object sought to be attained at the time the existing mode of measurement was established; and that object is, undoubtedly, sufficiently accomplished by the rules adopted. There is occasionally an indefiniteness in the measurement of the width at 7, the floor width of the midship cross-sections, arising from the flatness of the floor. In the writer's opinion it would be more satisfactory than the present mode to make this width a certain proportional part of the width next above it—that is, of the width at 6—leaving the shipbuilder at liberty to form the floor of his ship as he may conceive to be desirable. This would no doubt be not a rigorous mode of measuring the surface of a cross-section; but while absolute accuracy is practically unattainable in such operations, it would be sufficiently near the truth for the purpose, and would be without any element to induce an injudicious form of ship.

At the time the present mode of measuring the tonnage of ships was under discussion considerable diversity of opinion existed on the question, whether the register tonnage of ships should be proportioned to the internal capacity or to the external volume. In the writer's opinion, the proper answer to this question depends materially on the purpose for which ships are measured at all. If ships are measured for the purpose of providing means by which the work they are capable of performing can be compared; and if that work consists in carrying dead weight, the measurement for tonnage should plainly be external. But if the work consists in carrying what is technically called measurement cargo, the measurement should be internal. Whether dead weight or measurement capacity is of greater importance depends somewhat on the trade in which the ship is to be employed; but in the greater number of instances capacity for dead weight is the more important of the two elements. The writer is not aware of a single instance of a contract for building a ship in which measurement capacity has been stipulated for irrespective of dead weight, while many contracts have been made providing for dead weight irrespective of measurement capacity,—showing that in these instances external measurement was of more importance than internal capacity. If ships are measured for the exaction of harbour dues, lights, &c., the measurement should certainly be proportioned to the external volume, considering that the accommodation received in a harbour, and the benefit derived from lights, depend more on the external dimensions of a ship, and particularly on the draft of water, than on the internal capacity. It has been urged that, because iron ships are lighter than those built of timber, and, therefore, with the same external dimensions, capable of carrying greater cargoes, the measurement should be internal, instead of external, so as to deprive iron ships of this advantage, and raise wooden ships more nearly to the level of those of iron; but it appears to the writer that this fact is rather another reason why the measurement of ships should be external—the fact that, with the same external dimensions, there is a difference in the performance of wood and iron ships—in order that the best ship should be known, without reference to the material of which it is built.

A wood ship and an iron ship of 1000 tons, built for 12 years A, measured externally, will have respectively an internal capacity of* 820 tons and 890 tons, and will weigh respectively 820 tons and 690 tons. Thus, with external measurement, an iron ship of 1000 tons will carry † ten per cent. more dead weight than a wood ship of the same tonnage, measured externally, both being loaded to a draft of water leaving three inches of side for each foot in the depth of hold, and will have eight and a half per cent. greater measurement capacity; while with internal measurement, as at present practised, the iron ship will possess the same measurement capacity, and will have only‡ two per cent. greater dead weight capacity.

With internal measurement the iron ship draws less water than a wood ship of the same tonnage, and occupies less harbour accommodation, yet is made to pay the same dues as the larger wood ship drawing more water and requiring greater harbour accommodation; while, with external measurement, ships paying the same dues would draw the same water and occupy the same harbour accommodation. For these reasons the writer is of opinion that external measurement would have been the more equitable; although any change is now manifestly altogether out of the question.

Another question in the measurement of ships has been, whether in measuring steamers an allowance should be made in the exaction of dues for the space occupied by the machinery and fuel. To make a deduction from the tonnage of a steamer on which dues are levied is virtually a protective duty upon the application of steam; and although earlier in the history of that most valuable invention such a protective duty may have been desirable, no reason is now apparent why it should be continued. The object of the dues levied on tonnage is to support harbours, lights, &c.; and if the payments made by one part of the tonnage benefited by these harbours, lights, &c., is reduced, the payments made by the remainder of the tonnage must be so much greater. To reduce therefore, the dues paid by steamers is to increase the dues upon sailing ships; and the writer can see no reason why steam in navigation should be supported on principles now so much out of date, and so foreign to the policy of this country, except it be a reason that in the competition betwixt steam-ships and railways there may be a justifiable policy in giving steam-ships this relaxation.

The question remains, whether on tonnage there should be any allowance whatever to make the register tonnage upon which dues, &c., are levied different from the actual tonnage of a ship. So far as the writer can see, there is, with the exception of the allowance in the tonnage of steam-ships for the competition betwixt steamers and railways, no abstract reason why the register tonnage of a ship should be different from the actual tonnage, unless an allowance is deemed to be desirable to stimulate the sanitary construction of ships in the use of round-houses for the protection of deck passengers, and the adoption of improved accommodation for the crew.

The register tonnage of ships, both steam and sailing, for the purpose of levying dues, &c., may be, and probably ought to be, different from the tonnage used in the application of Lloyd's Rules to define the strength of ships. A ship with a spar deck, for example, or with a house amidships, extending from side to side, is a very different ship in point of strength from one of the same tonnage built with a poop, or quarter deck, or round-house, which does not extend from side to side. It may be that in ships constructed with a poop, quarter deck, or round-house, the tonnage used in the application of Lloyd's Rules should be not the net gross measurement of the ship, but a greater tonnage, in which the poop, quarter deck, or round-house would be taken at a tonnage beyond the exact measurement in a determinate ratio, to compensate for the weakness inherent to a ship so built. The question is, however, beyond the scope of this paper, and need not now be considered.§

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* An iron ship of 1000 tons internal measurement will carry a dead weight cargo of = 1,500 tons, which, added to 775 tons, the weight of the ship, gives a displacement of 2,275 tons. A wood ship of the same internal measurement has a greater displacement in the ratio of 1·319 to 1·221, and has therefore a displacement of 2·473 tons. This displacement, reduced by the weight of the ship, 1000, leaves a dead weight cargo of 1·473 tons, being within two per cent. of the cargo of the iron ship.

† In timber ships the internal capacity is 82 per cent. of the external volume, while in iron ships it is 89 per cent. The weight of timber ships is taken at 20 cwt. per ton of internal capacity, and the weight of iron ships is taken at 15½ cwt.

‡ An iron ship of this size (1000 tons externally and 890 tons internally), and loaded to this draft, will carry 1½ × 890 tons of dead weight = 1335 tons; while a wooden ship of the same external measurement will carry only = 1335 + 690 − 820 = 1,205 tons. The internal capacity is, as already stated in the text, in the ratio of 820 to to 890, in the favour of iron ships.

§ From what has been said it will be apparent that if it be required to build ships capable of carrying the greatest amount of dead weight cargo, the capacity of the ship should be as much as possible under the load draft line. Ships built with poops, quarter decks, or measurable round-houses, cannot carry as much dead weight as ships of the same tonnage built without these measurement spaces. The sheer of ships diminishes the dead weight carrying capacity, and plainly the sides built with a considerable amount of tumble home increases it.

ROYAL SCOTTISH SOCIETY OF ARTS.

NOTICE OF A SIMPLE IMPROVEMENT ON SHIPS' ANCHORS.

BY HERIOT CURRIE, Engineer to the Northern Lights steamer *Pharos.*

Much attention has of late been called to the ground tackle of ships, from the appalling wrecks which so frequently occur on our coasts being too often traceable to defective mooring.

While probably little can be done for cables, except making them of the best materials and in the most careful manner, the anchor is susceptible of considerable modifications, and it is now constructed in various ways which the several inventors consider the best for obtaining the strength and bite rendered necessary by the large size of modern ships without unduly increasing its weight and size.

Without attempting to express any opinion on the merits of the various patent anchors which are now more or less commonly to be met with, I may mention that the anchor, with flukes of the form patented by Trotman, and connected with the shank by a pin or joint, has come into very general use; and it is to this anchor, or any other with moveable flukes, that the improvment which I have invented is adapted.

FIG: 1.

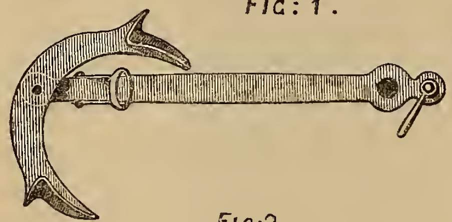


FIG:2.

There appears to be little doubt that the pin or axis on which the flukes turn is the part of the anchor which is most liable to failure, and besides the possibility of its giving way from unperceivable defects in the metal of which it is made, there is also a danger of the cutter, which keeps it in its place, dropping out, or of the end of the pin through which the cutter passes being broken off by its accidentally coming in contract with a projecting point of rock. In either way, the pin would become loose and might work out, either from a varying strain on the cable, or from the vessel swinging to wind or tide. On board the Northern Lights steamer *Pharos* alone, it has happened on two occasions that the shank came home and left the flukes at the bottom, while at another time it was found, when the anchor was brought on board, that the cutter had been lost, and the pin itself had nearly dropped out. On the very day before one of the occasions on which the flukes were lost, the *Pharos* was anchored on a dangerous lee shore, and had the anchor given way then, instead of the very next time of anchoring, the vessel would in all probability have been totally wrecked.

FIG. 3.

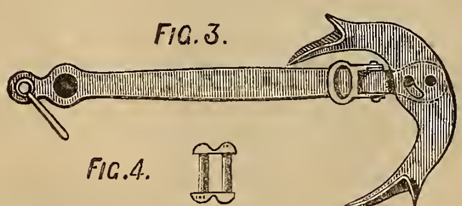


FIG. 4.

FIG. 5.

The improvement which I propose, and which would entail little additional expense, is to have two pins to connect the anchor flukes with the shank—one made as at present, and serving as a centre on which the flukes turn—the other fitting tight in the shank and working in a circular slot in the flukes. The pins, as shown in the drawing, have their heads so formed as to lock each other in, so that should one of the cutters drop out, or should the point of a pin be broken off (an accident much less likley to happen than before, as the rounded head of the one pin protects the point of the other from injury), the damaged pin will still be of service, as it will be prevented from dropping out by the head of the other; while, should one of the pins even give way entirely, the anchor will still be as secure as any of those at present made with flukes moving on one pin.

Fig. 1 is an elevation of anchor with flukes turning on one pin, as at present constructed, part of the shank being shown in section to show the shape of the flukes and the position of the pin.

Fig. 2 is a longitudinal section of the present anchor through the joint.

Fig. 3 is the elevation of anchor of the form I propose, with two pins; the shank partly cut away to show the arrangment.

Fig. 4 shows the pins detached, and with the locking part of the head of each pin forged with a rounded swell, so as more effectually to protect the point of the other. Each cutter in this arraugement passes through the head of one pin and the point of the other.

Fig. 5 is a longitudinal section of the anchor with two pins through the joint, showing the manner in which one pin locks the other.

INSTITUTION OF CIVIL ENGINEERS.

ON RAILWAY TELEGRAPHS, AND THE APPLICATION OF ELECTRICITY TO THE SIGALLING AND WORKING OF TRAINS.

BY MR. W. H. PREECE, C.E.

In the two papers on "Railway Accidents," by Mr. Brunlees and Captain Galton, read at the Institution during the last session, it was shown that 27 per cent. of the accidents arising from preventible causes were due to a want of the electric telegraph. No mention was then made of accidents attributable to the presence of the telegraph, of which several instances could be cited, and which had even led to an argument being maintained against its utility; but it was contended, experience had proved that, in particular localities, such as the Victoria Station (Pimlico), the New-street Station (Birmingham), the Lickey, and other steep inclines, and long tunnels, its employment was imperative. The author did not, however, advocate the general and indiscriminate adoption of the telegraph, as a primary power, in the working of railways. It was, like many mechanical arrangements, and uncertain agent, and its chief advantage lay in its secondary or auxiliary character, in which capacity it was invaluable.

The Author then proceeded to discuss the various systems that had been introduced in working long tunnels, single lines, steep inclines, drawbridges, and other exceptional cases; alluding incidentally to the supposed superiority of working lines by an interval of space in preference to an interval of time.

The first application was that of Mr. Cooke, the original introducer of the electric telegraph into practical use for railway and commercial purposes. He suggested and established on the Eastern Counties Railway, between Norwich and Yarmouth, in 1844, what was now known as the 'block' system. A line of railway was divided into sections, each having its own telegraph, which regulated the line signals, and prevented the admission of a second train upon the same length of line. For this purpose a needle instrument was employed, which showed the presence of a train upon any particular section. The author pointed out that, by making the out-door signals a representation of the indications of the needle, distant stations could be worked like distant signals; and, consequently, that instead of these signals being confined to distances of about 1000 yards, by the aid of the telegraph the distance could be increased *ad infinitum.* Most railway companies, in working long tunnels, &c., employed simply a single needle speaking instrument, which, by a momentary deflection of the needle on one side, gave 'train in,' and on the other 'train out.' Only these two signals were used on the entry and exit of trains. This plan was condemned as being faulty and inefficient.

Mr. Edwin Clark (M. Inst. C.E.) perfected the scheme of Mr. Cooke, in the system he introduced upon the London and North-Western Railway, which was fully described. The needle instrument was employed, but its indications were made permanent by the use of continuous currents of electricity. It not only showed when the line was clear, and when there was a train on the line, but also the occurrence of an accident This last signal was produced by rupturing wires that descended every alternate pole on the line; but this plan was thought to be dangerous. The London and North-Western Railway Company did not strictly adhere to the 'block' system. They allowed two, three and sometimes four trains to be on the same length at the same time. The 'train on line' signal was only accepted as a caution, and not as a danger signal. This was a partial expedient, which provided a certain amount of safety, but it was not considered sufficient under all circumstances to prevent collision. A somewhat similar, but less complete, system was adopted on the Great Northern Railway; permanent signals were not used, but carefully kept record books were maintained in which all signals were entered.

The advantages and disadvantages of speaking telegraphs in connection with signalling apparatus were considered, and it was maintained that a speaking telegraph should never form a portion of a signalling system, but be a separate and independent agent. The objections to the needle instrument, as regarded its transitory signals, and its liability to reversal, demagnetization, and injury by lightning, as well as its capability of being converted into a conversational medium, were stated to be partially avoided in Mr. Tyer's, and in Mr. Bartholomew's systems. The former was used on the North London and several other lines; the latter on the London, Brighton, and South Coast Railway. Mr. Walker's system of bells, on the South Eastern line, by which an indicator was dispensed with, and dependence placed solely on sound, was mentioned. The French system of M. Regnault, which did not differ essentially from Mr. Clark's—excepting that the "block" was maintained by self-acting mechanism, and not by hand—a questionable alteration—was described. The French "appareils de demande de secours" and the German bell system were deemed to be impracticable in England.

It was shown that, in all these systems, the two signals, danger and safety, were not sufficiently opposite in their indications to be unmistakeble, and that this was obviated in an instrument invented by Mr. Highton, in 1854, and recently applied on the Great Western line by Mr. Spagnoletti. Written words were given in place of the deflection of a needle. Moreover, the signals in all these systems were so dissimilar to those used out of doors, that the signalman had to master and to retain on their mind two systems, the one line signals, to regulate the trains, the other electric signals, to regulate those of the line. The author then proceeded to describe how he had assimilated, on the London and South Western railway, the electric to the line signals. The instrument used by him was an exact counterpart, on a small scale, of the signals employed on the line, whether semaphore, disc, or otherwise, and it was worked in a precisely similar manner. The electric signal was simply a distant signal; and it was contended that, if a system of signalling was found sufficient to work the trains by manual power, the same system must be equally efficient when manipulated by electrical agency.

The North-Western, Mr. Tyer's, and the South-Western systems—as embracing the principle of all those in use—were compared and their relative superiority discussed. It was argued, that, while the North-Western and the South-Western systems met nearly all the conditions laid down, Mr. Tyer's system failed to do so, and, under some circumstances, had been proved to be objectionable.

Various self-acting arrangements for communicating between two trains, or a train and a station, or signals and an engine, or signals and a station, &c., were alluded to, and their impracticability shown.

The danger of using the telegraph as a medium of converstion, without carefully writing down everything sent and received, and the necessity of repeating every important message, were adverted to. The use of record books, as a check upon the telegraph, was also advised.

The method of working single lines by telegraph was then discussed. This could be done in two ways, either in a primary manner, by means of a signalling apparatus, or in a secondary manner, to give notice of the delay of trains, to hurry on one train, to stop another, to alter the authorised passing places, and to prevent the unpunctuality of one train affecting all the rest. The system in use on the London and South Western line, and in America, in which the latter plan was employed, was descrided. It was argued that single lines, properly worked, would be sufficient to meet a great portion of the traffic of this country; and that large sums of money had been uselessly expended, in consequence of Parliament compelling railway companies to make double lines, where a single line would have been ample for the requirements of the district. This had been owing to the absence of a reliable signalling apparatus, and the want of confidence in, or knowledge of, the telegraph by railway managers. With a well-managed speaking telegraph to regulate the trains, and a reliable signalling apparatus to regulate the signals, safety and regularity were assured; and single lines might be worked as securely and as rapidly as double lines.

The low estimation in which the telegraph was held, and the little consideration it received on the part of railway officials, were regretted; and while it was admitted that where indiscriminately used, the telegraph might become a positive source of danger, yet when carefully applied it would be found to be the greatest element of security.

ON THE WOODS USED FOR SLEEPERS ON THE MADRAS RAILWAY.

By Mr. Bryce McMaster, M. Inst. C.E.

The native wood sleepers having hitherto been found for the most part to fail, —on the Madras Railway between 30 and 40 per cent, requiring to be renewed annually,—the Author undertook an investigation with a view of ascertaining the causes of this deterioration, and whether those causes could be overcome, so as to render available the vast resources of India. Thirteen hundred sleepers, of sixteen different woods, were submitted to careful examination and scrutiny twice at an interval of twelve months. The sleepers were variously placed, both on embankments and in cuttings; in some cases they were entirely covered with ballast to a depth of 4 inches, while in others they were as much as possible uncovered, and completely so from the rails to the ends, the ballast being only raised 2 inches in the middle of the way, and sloped off so as to carry away the water under the rails. From these observations it appeared, that only five woods,—Chella Woonjay, Eloopay, Kurrah Murdah, Palay, and Karavalum,—were sound at the end of two years, the other eleven not lasting even that time. Also, that when the sleepers were uncovered, decay was less rapid than when they were buried in the ballast. The plan of leaving the sleepers partially uncovered had many advantages; it effected a saving in the ballast, allowed the defects to be more quickly detected, and kept the sleepers drier. It had been urged, that the heat of the sun would split the sleepers, and cause the keys and trenails to shrink; but from experience the Author was enabled to state that, while amongst the "uncovered" sleepers there was a larger proportion "beginning to split," or "useless from being split," there was, on the other hand, amongst the "covered" sleepers, a still larger proportion "beginning to rot," or "useless from being rotten.' It was also noticed, that of the sleepers "beginning to rot," 19 per cent. had commenced under one or both chairs. This was due to the retention of moisture under them, and might be remedied, the Author believed, by tarring the seats of the chairs. As regarded the trenails, where the sleepers were rotten, the trenails were invariably found to be in the same state; while when the heads were exposed to the sun, he never found them loosened by shrinking. Another objection was, that the road would be more liable to buckle and twist, but this was not found to be the case on the 40 miles of line, thus ballasted and opened for traffic, on the division under his charge. Trenails made in India cost £2 10s. to £4 per thousand, and the woods generally used for the purpose were Vengay, Kurrah Murdah, Erool, Porasa or satinwood, and Trincomalee. The three woods first-named were also extensively employed for keys, which were considerably larger than usual; but Teak keys seemed to be the best, and their cost did not exceed £6 per thousand. From personal observation and enquiry, the Author thought the following woods would make really good sleepers, to be used plain:—Teak, Saul, Sissoo Pedowk, Kurrah Murdab, Aucha, Vengay, Chella Woonjay, Erool, Karavalum, Dud Eloopay, and Paulay.

The sleepers which had failed on the Madras Railway might be divided into two classes—those which were originally of perishable woods, and were therefore unfit for the purpose, and those which, although of good woods, had been cut from young trees, and not been allowed to stand till old enough. The first arose from want of experience in Indian woods, the second to the absence of a proper system of working the jungles. The conditions under which the sleepers were supplied to the Railway Company, either through native contractors possessed of capital, or by purchase direct from the wood-cutters or others, having been found to fail, the Author suggested that in future the Company should send their own agents, with sufficient establishments, into the jungles to cut down the wood, that the wood-cutters should be furnished with proper appliances, and their operations be carefully superintended. This was done in one or two instances on the Madras Railway, with great success. In particular from the Palghaut Jungles, Mr. Ross, one of the resident engineers, was able to furnish sleepers for nearly eight districts, while on other portions of the line the supply required for one district of 25 miles could only be obtained from a great variety of sources. But as the Indian Jungles abounded in woods of too perishable a nature to allow of their being used plain, the Author recommended that the sleepers should be creosoted on a much larger scale than had yet been attempted in that country, and those so preserved which had been sent from England, answered admirably. The process had not yet been fairly tried in India, as only Saul. Teak, Soondry, Sissoo, and other hard close-grained woods had been submitted to it; while the cheaper, more easily procured, lighter and more open-grained woods had been neglected. English creosoted sleepers, led, say, 100 miles by rail and 50 miles by road, cost 9*s*. 6*d*. each; while good, native wood, plain sleepers delivered at the works averaged 6*s*. each. If establishments and apparatus for creosoting were erected in convenient positions near to each extensive jungle, it was believed sleepers of common wood might be procured for 4*s*. 6*d*. each, and be creosoted for about 1*s*. each.

In proof that the resources of India were likely to be equal to the demand, reference was made to the Report of the Conservator of Forests for the official year 1859-60. From this it appeared that from the Salem Jungle alone—one probably of twenty in the Madras Presidency—about 246,000 sleepers, or sufficient for 133 miles of railway, had been cut during that year. Of this number about 62 per cent. could not be used plain, and were practically useless, owing to the want of artificial means for preserving those of a perishable nature. But as a supply from each jungle of 2000 sleepers per month would provide for the construction of 500 miles of railway in that Presidency within the next five years, and for a renewal of 33 per cent. of those already laid, it might be confidently anticipated that the supply would not fail, if means were taken to make the naturally perishable sleepers last a reasonable time.

In conclusion, the Author recommended that a fair trial on a new footing be made with the native wood sleepers; that all woods now known, or hereafter found to be good, be used plain, and that others be avoided; that proper care be taken in the selection, felling, and seasoning of the timber; that the sleepers be tarred under the seats of the chairs, and that they be laid in dry ballast, raised slightly in the middle, and sloped off so as to throw the water under the rails.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

ON THE BURNLEY COAL FIELD.

Mr. T. T. Wilkinson, F.R.A.S., said that, in the paper upon this subject, prepared by Mr. Joseph Whitaker, of Burnley, and himself, and read before the Geological Section of the British Association, at Manchester, they gave a sketch of the principal mines in this district, but they purposely omitted all mention of those whose thickness did not exceed one foot. There are, however, one or two of these thinner mines which may hereafter become worthy of notice, and hence he offered the present note as an addition to Mr. Hull's valuable synopsis in pp. 133–4 of his *Coal Fields of Great Britain*.

Section of Strata near Worsthorne, Burnley.

	feet.
Strata composed principally of blue clay, followed by light metals	102
1.—Coal, the "China Bed"	2
Strata, consisting chiefly of grey rag and metal	39
2.—Coal, the bed not named, and overlaid by about three inches of cannel, together	$1\frac{1}{4}$
Strata, composed mainly of dark rag and metal seating	73
3.—Coal, the "Danby Bed"	$2\frac{3}{4}$
Strata, consisting of rag, light blue rock, metals, and black shales	126
4.—Coal, the Arrey, or Habergham mine	$4\frac{1}{2}$

The bed (2) is the one which has been hitherto omitted; and, if of no other value at present, it may be useful for co-ordination and identification with the seams of coal in other localities.

ON THE NEW RED SANDSTONE AND PERMIAN FORMATIONS AS SOURCES OF WATER SUPPLY FOR TOWNS.

By Edward Hull, B.A., F.G.S.

The paper commenced by pointing to the advantage enjoyed by most of the large towns of the central counties from their geological position, when built on the new red sandstone. First, from being in proximity to coal; second, from having a dry foundation; third, from having easy access to building stone; and fourth, from the fact of their resting upon natural reservoirs of water stored up in the sandstone itself. The Author considered that many of these towns had not taken full advantage of this last-named source of water supply, partly from a distrust of the resources of the rock, and partly from the failure sometimes sustained in consequence of the positions for the wells having been selected without a proper regard to the geological structure of the country.

The excellence of the new red sandstone and the lower permian sandstone as sources of water supply, was shown to depend upon three qualities. I. Their porousness; Homogeneity, or uniformity of structure and composition; 3. Filtering powers. Each of these were treated of in detail, and with examples from several wells in Lancashire and Cheshire. The Author then referred to the failure of the attempts to obtain fresh water at Rugby, and a sufficient supply at Wolverhampton; and he maintained that an abundant supply might have been found at the latter town had the position for the well been selected with due regard to the geological structure of the country.

The Author then proceeded to lay down certain rules of general application for the selection of proper sites for wells, and illustrated the subject by reference to a well now being sunk under his direction at Whitmore, for the supply of the railway works and town of Crewe. The position of the well is in a trough, both geographically and typographically, and on a four-inch bore hole being sunk to a depth of 148ft. the water ascended to the surface with a head of four feet, and has continued to flow without diminution for the last six months. The well, which is being made within 100 yards of the bore hole, has only reached a depth of 60ft., but already yields 250,000 gallons per day.

In conclusion, the Author expressed his conviction that the question of water supply from the strata was becoming every day more a geological one, just as was the discovery of coal beneath the formations which overlie the coal-measures.

NOTICE OF A COMPRESSING AIR PUMP.

By Dr. J. P. Joule.

The Author referred to the difficulties of realising in practice the theoretical advantages of the air, or the superheated steam engine. The abrasion which takes place when metal rubs against metal, without an intermediate lubricator, speedily destroys the cylinder. He believed that the necessity of using elastic packing would not exist if the length of the channel along which the elastic fluid must pass, in order to arrive at the opposite side of the cylinder, were sufficiently increased. This might be accomplished by increasing the depth of the piston, or by placing on the rim of the piston concentric rings to enter, at the beginning and end of each stroke, corresponding concentric grooves in the covers of the cylinder.

The principle of great depth of piston, as a substitute for packing, had been successfully carried out in the pump which was the subject of this communication. The cylinders, two in number, are twenty inches long and two inches in diameter. The pistons are solid cylinders of iron, ten inches long, fitting as accurately to the cylinders as is consistent with freedom of motion. The depth of each piston, as compared with its diameter, renders the usual guide or parallel motion unnecessary, so that the connecting rod is simply jointed to the top of the piston. Air is readily compressed to sixteen atmospheres, the quantity passing the sides of the cylinders being very trifling.

ON SWELL OBSERVED AT SEA, PARTICULARLY IN THE REGIONS OF THE SOUTH-EAST TRADE WIND.

By Mr. Thos. Heelis.

The Author, after examining the causes of swell and giving instances and especially alluding to the rollers at Ascension, St. Helena, and Tristan d'Acunba, gave some instances of the observed succession and order of the undulations in altitude and of the speed of translation of the crests, which in one instance he had found to attain twenty-two miles per hour; and after setting forth a table of different instances of swell, chiefly in the Atlantic and Indian Oceans, and Bay of Bengal, addressed himself to the consideration of the swell which is frequently observed in tropical latitudes in the southern hemisphere to roll up from the southward. This he attributed to the action of currents setting especially in the Indian Ocean from the neighbourhood of the southern tropic, towards the great connecting current which extends from the Cape of Good Hope to Australia. The Author gave instances of these currents experienced in

30°47′ S.	79°10′ E.	running south	27	miles in 24 hours.
28°22′ S.	81°13′ E.	” ”	27	” ”
26°42′ S.	81°45′ E.	” ”	23	” ”
23°38′ S.	83°10′ E.	” S. 50° E.	42	” ”

And called attention to the difference between them as actually experienced, and the set of the water as laid down upon general current charts, the peculiar circulation which they shewed to exist at times in the Indian Ocean, and the meteorological disturbances which the causes which set such currents in motion cannot fail to originate.

NOTES ON THE INTRODUCTION OF STEAM NAVIGATION.

By Mr. Dyer.

Mr. Dyer stated that this subject, being of great importance, had engaged many able pens in tracing the origin of the several inventions and experiments that preceded the final triumph of steam power over that of wind for navigating ships; each writer claiming the honour of priority for his own country. It may be useful to state the order in which, and the parties by whom the principal attempts were made to realise that object. Several letters lately appeared in the *Times*, and were thence transferred to the pages of the *Engineer*, giving a graphic account of the "first steamer in English waters," the "*Margery*, built at Dumbarton, by the late William Denny, for William Anderson, of Glasgow, and passed through the canal to the Forth and thence to the Thames, where she arrived on the 23rd January, 1815." On the authority of Mr. Anderson, then, this date is fixed when the first steamboat was seen on English waters. The first steamboat, the *Claremont*, was started as a regular packet on the Hudson River, in the spring of 1807; so that the first steamer seen on the American waters was fifty-five years ago, a lapse of time that should now insure a calm view of the steps that led to this first actual success in steam navigation. It will be shown that, by a long course of persevering labours, the honor of that success must be conceded to Robert Fulton, by whom it was achieved.

Whilst admitting the merits of other ingenious men long engaged in the same pursuit, it is clearly proved that, either from good fortune, or by the exercise of superior judgment and skill, the race was won by 8 years' priority of steam navigation, by Fulton, on the Hudson River.

In 1793, Mr. Fulton sent his plan for a steamboat to Lord Stanhope, who approved of, and thanked him for the communication. Shortly after, Fulton went to Paris, and made experiments on the French waters, with the chain floats, the duck's-foot paddles, the screw or smoke-jack propellers, and with the paddle wheels, to which latter he gave the preference, and constructed a boat with them in 1803, which was the model adopted in building the *Claremont*, in 1806.

Mr. Dyer had sailed in the *Claremont*, and remembers the sensation created by her appearance, and the high admiration bestowed on the author of so great an enterprise. That sensation in 1807 was precisely the same as the *Margery* created among the vessels on the Thames in 1815.

All attempts at steam navigation were fruitless before the invention of Mr. Watt's steam-engine, his engine being the first that could be usefully applied to rotative machines on land, and therefore for propelling ships. The principal claims put forth by other inventors of steamboats, are the following:—

In France, the Marquis de Jauffroy constructed a steamboat at Lyons, in 1782, "with paddle wheels," but that this boat did not succeed is obvious, because she was not heard of until 1816, when the first Fulton boat was started to run on the Seine.

In 1783, Daniel Bernoulli proposed a plan which consisted of forcing water throug a tube, out of the stern of the boat. This scheme has been tried many times since, but fails on account of the defective principle of applying the force. Endless chains, with float propellers, have been many times tried and have failed on the same ground,

In 1795, Lord Stanhope made experiments with a boat on the Thames, using the reciprocating or "duck's foot" paddles, which also failed, from the loss of time and power by the return stroke.

In 1785, James Rumsey, of Virginia, tried a boat on the Potomac, and afterwards in London, both without success; and about the same time Mr. Fitch, of Philadelphia, tried one with paddle wheels, on the Delaware, but this boat also did not succeed and was given up as a failure. J. C. Stephens, of New York, made experiments in 1804, with a "boat 25ft, long and 5ft. wide," which of course did no good, and was stopped as a failure, though again brought to notice as preceding Mr. Fulton's.

In 1788 and 1789, William Symington, in conjunction with Patrick Millar and James Taylor, made experiments with their patents for navigating by steam, and in 1802 commenced running a boat on the canal at Glasgow which made three miles an hour, but after many changes of propellers and trials, the scheme was given up, and no more was heard of the steamboat of Mr. Symington until long after those of Fulton were widely spread over the American waters.

In 1816, the Marquis de Jauffroy complained that the Fulton steamboat on the Seine had taken the "paddle wheels" invented by him and used at Lyons thirty-four years before, but also abandoned by him. To this charge Mons. Royou replied in the *Journal des Debats*, thus:—"It is not concerning an invention, but the means of applying a power already known. Fulton never pretended to be an inventor in regard to steamboats in any other sense. The application of steam to navigation had been thought of by all artists, but the means of applying it were wanting, and Fulton furnished them."

The first ocean steamer was the *Fulton*, of 327 tons, built in 1813, and the first steamer for harbour defence was built under Fulton's direction, 2470 tons, launched in 1814. This became the model ship for the iron-clad batteries and rams since constructed with many changes. It will be seen by the drawings of Fulton's plans, that he had tried the several other kinds of propellers—the chain float, duck's foot, and the screw fan—before adopting the paddle wheel, for though the screw was good in principle, it was many years before it could be constructed to act efficiently. The *James Watt* was the first boat with the screw running between London and Havre, about ten years after the advent of the *Margery*.

In 1811 I endeavoured to introduce steam navigation into England, but I found a strong conviction that it would not answer in this country, our most eminent engineers saying, "We don't doubt the success of steam-boats in the wide rivers and harbours of America, but in our comparatively small rivers and crowded harbours they will never answer." Even such scientific engineers as the late John Rennie, sen., and Peter Ewart, a Vice-President of this Society, both advised me to relinquish the attempt to introduce steamboats, as sure to prove a waste of time and money to no purpose. However, when conviction came over the

public mind that steam navigation would answer here—but not until after more than 5000 tons of steamboats had been launched on the Hudson in 1816, did it so come—then began the spread of steam navigation, since extended with such marvellous rapidity and perfection as to atone for the sluggish beginning. Since nations are indebted to the genius of Watt for success in using steam power, to that of Fulton for its successful application to navigation, to Stephenson for the like success on railways, the meed of praise due to each of their names should be cheerfully awarded by all who are so largely benefited by the result of their labours. In doing this we should bear in mind, that inventions do not spring into existence perfect from their birth, like Pallas from the brain of Jupiter, but they come from the prior labours of many brains, and he is the true inventor who first collects the essence of and gives the stamp of vitality to those labours. In this sense the invention of steam navigation will for ever illustrate the name of Robert Fulton.

ROYAL GEOGRAPHICAL SOCIETY.

ON OCEAN CURRENTS ON THE NORTH-EAST COAST OF SOUTH AMERICA.

By J. A. Mann, F.R.G.S.

The object of the paper was to present an account of the voyage, in July and August, 1862, of the *Monte Cristo* from Cayenne, in Guiana, to Paranahiba, in Brazil, in which some extraordinary phenomena connected with the Guiana current were experienced. The popular idea is that this current always runs in a north-west direction, at a rate varying from one to four knots per hour; but in this voyage of the *Monte Cristo* it was found that the current was entirely reversed, running at a rate of 4¾ knots per hour—a circumstance which, if proved, would upset the received ideas not only on the subject of this particular current, but of the entire ocean streams. Much evidence was adduced, and well authenticated, to prove the phenomena described, and although, as Mr. Mann stated, he was not able to secure as satisfactory observations as he could wish, it seemed that there was no good reason to doubt its existence.

Captain Maury (formerly of the U.S. navy, but now a well-known Secessionist,) remarked that when he was at Bermuda, on his way to England from South Carolina, he met some officers of her Majesty's Navy who had been on the North American station several years, and they told him that on the passage from Halifax to Bermuda, they found the Gulf Stream actually running to the southward and westward, and that they observed precisely the same condition of the current on their return to Halifax. It showed that there were exceptional cases, of which the one detailed by Mr. Mann was an instance which was well known to all Brazilian navigators. Mr. Capello, of the Meteorological Observatory at Lisbon, had established the existence of a well-marked current on the north of the Equator setting to the east, and of an equally well-marked current just to the south of the Equator setting to the west. He had also found that a little to the south of the De Verd Islands, taking the form of an ellipse, there is a region in which the north-east trade-winds blow with the greatest force; and, in like manner, he had found in the neighbourhood of St. Helena towards Cape St. Roque, a region where the south-west trade-winds blow with the greatest force. If, therefore, there were so many exceptions with the winds, which have so much to do with currents, we might well find exceptions in the currents themselves.

ON THE QUESTION OF A SURVEY OF THE PHYSICAL CONDITION OF THE ATLANTIC, PRELIMINARY TO THE LAYING DOWN OF ANOTHER ELECTRIC CABLE CONNECTING EUROPE WITH NORTH AMERICA.

By Dr. G. C. Wallich.

The author began by pointing out that both the amount and kind of information we now possessed regarding the deep-sea bed of the Atlantic were altogether inadequate to meet the requirements of oceanic telegraphy. Referring in proof of this to the line of soundings taken by Captain Dayman, in 1857, on board her Majesty's ship *Cyclops*, he observed that these, though as perfect as circumstances then allowed, furnished data necessarily incomplete; inasmuch as only 41 soundings were taken at depths exceeding 250 fathoms, across an area of 1300 miles of ocean, leaving a mean interval of 32 miles between each two soundings. Having assigned his reasons for disbelieving that the entire central basin of the Atlantic is, as many have supposed, a vast plateau unbroken by alternations of level as great as those existing on land, he observed that in the intervals between the previous measurements of the depth of the ocean-bed, some of the largest mountain ranges might very well be included—a matter obviously most important, as bearing upon the safe laying of a telegraphic cable. True, no such submarine slopes had hitherto been detected in the mid-Atlantic, but the data on which it was assumed that they did not exist there were, he maintained, purely arbitrary. A sounding of 100 fathoms had been taken by Lieutenant Saintbill, R.N., within about 32 miles of one of 3000 fathoms, taken by Captain Dayman. Dr. Wallich then enumerated the various kinds of observations that he thought essential to a trustworthy telegraphic survey, among which was a method of probing the deposits of the sea-bed, with a view to determine their geological character. He exhibited an ingenious instrument, designed by him to effect this object, besides other new apparatus for raising specimens of water from any desired depth, and for gauging the pressure at all depths. Passing to the means requisite for carrying out his survey, Dr. Wallich recommended that the Government should equip two steamships for the work; the great novelty of his plan consisting in the two vessels sailing in parallel courses, removed only 2 miles from each other, and the soundings being taken alternately on each line of the longitudinal belt thus defined. While, therefore, there would be an interval of 5 miles at the utmost between any two soundings on the same line (that was, taken by the same ship,) there would be an interval of only 2½ miles between those on alternate lines. Having indicated how a minuter inspection of doubtful or dangerous areas might easily be effected, he suggested that Captain Dayman's line of soundings should form, as it were, the base of operations, and be taken as the centre of the 2-mile longitudinal belt which he proposed to have surveyed. The entire work might, he thought, be finished in five or six months. Summing up the advantages of his plan, he remarked that it would furnish no less than 640 reliable observations, extending across the entire deep water of the Atlantic, and affording a basis upon which its old sea-bed might ultimately be mapped out. In conclusion, he said the task was unquestionably arduous. Its execution might prove costly and tedious. But there it was, staring us in the face—a task which we must either manfully grapple with and master, or leave unfulfilled to our successors the accomplishment of the grandest international project that human sagacity had heretofore suggested.

Sir R. Murchison reminded the meeting that Dr. Wallich accompanied Sir Leopold M'Clintock in his North Atlantic explorations, and had since published a valuable work on the natural history part of the exploration. In his elaborate paper he had thrown some light on the nature of the animals existing at the bottom of the sea, and on the varieties of soils, and even subsoils, that were to be found there; for with the ingenious apparatus which he had explained, he was able not only to tap the soft strata, but even to bore into the solid rock. The survey which he proposed was a preliminary one, and essential before any attempts were made to lay down a telegraph cable across the Atlantic. At all events, whether any adventurous persons chose to undertake that preliminary survey, it became us, as a great maritime nation, to ascertain as accurately as possible the condition of the bed of the ocean between England and America, with the view to telegraphic communication being established.

Sir Edward Belcher, R.N., as the senior surveying officer present, thought it his duty to answer some portion of the paper. Such a project as Dr. Wallich proposed would answer very well across the Irish Channel; but from his experience in searching for shoals even within 100 yards of his own ship, for six weeks and fourteen hours a day, he knew the difficulty of finding a rock, not much larger even than the President's chair. Any such survey, therefore, would cost an immense sum of money, would incur more labour than the men would like and would be attended with innumerable difficulties, which would render the carrying out of such a project absolutely impossible. For a telegraph cable, it was not the deepest water that was wanted, but a line of bottom which would give mud and avoid mountains: nor did he think many scientific men were of opinion that it was desirable to carry a cable straight across the Atlantic. If they carried the line from the Hebrides or the Orkneys to the Faroe Islands, and so on in that direction, a simple mode of being sure of what they were about would be secured: they would know, with such small lines, positively what bottom the cable would lie upon. To carry a cable from point to point might be done at a small expense, and in that way they could feel their way across the ocean. With reference to the apparatus explained by Dr. Wallich for sounding the bottom of the ocean, he might state that in the soundings which he carried on in 1835 and 1836 a very accurate instrument was used, not only for sounding, but also for determining the temperature at different depths and bringing up the water. He explained the construction of that instrument, and stated that it was in use for a period of twelve years without the slightest derangement of even the delicate thermometers that were attached to it. He thought, before the Government was moved to incur the cost and labour of carrying a line of soundings across the Atlantic, the opinions of scientific men should be taken as to whether it would not be better to have several stations for the cable, instead of one long line.

Admiral Elliott doubted whether the survey proposed by Dr. Wallich would render them any wiser with regard to the laying down of the Atlantic cable, because it was impossible to thread their way across the ocean in the way Dr. Wallich supposed, and avoid mountains and hollows that might be found to exist. Nor did he think such a method of sounding practicable; and to keep the laying of the cable in abeyance till it was accomplished would be inexpedient.

Professor Tyndall said, as far as the physical objects indicated in the paper were concerned, he did not think they were of sufficient importance to justify any great outlay. He confessed he had arrived at a conclusion somewhat in accordance with that of Sir Edward Belcher and Admiral Elliott. Even if Dr. Dr. Wallich's survey were carried out, it could not, with five miles intervals, give an accurate view of the bed of the ocean; knowing what we did of the variations that occur within five miles on the earth's surface, how easily such a projection as that of the Matterhorn might be missed.

Captain Selwyn, R.N., said the diagrams of soundings taken by Captain Dayman, R.N., not having been thoroughly understood, had given rise to the supposition that there was a precipice off the shores of Iceland. He had been engaged, in company with an officer of the Admiralty, to measure the exact distance between the soundings and the depths, and they ascertained that the fall on the bank in question was not greater than that of Holborn Hill. No one would imagine that a cable would be injured by such a descent as that, nor that there were precipices so abrupt as to hold the cable on the stretch between them. Again, it was utterly impossible to find out whether abrasion would be caused, and it would be combating with theoretical difficulties to delay laying the cable until the exact character of the bed of the ocean between England and America had been thoroughly determined. With respect to the best route, he could suggest a shorter one by 300 miles, by taking the cable to the Flemish Banks, 300 miles this side of Newfoundland, where the depth varied from 30 to 200 fathoms. He also thought that the proper method of survey would be to adopt the system of triangulation.

Mr. Webster argued that the laying of the cable would of itself enable us to obtain a knowledge of the bed of the ocean much more effectually than by any survey.

Dr. Wallich briefly replied, defending his plan from the objections that had been urged against it, and adducing further reasons against the adoption of the counter telegraph-route suggested by Sir E. Belcher.

REVIEWS AND NOTICES OF NEW BOOKS.

The Year Book of Facts in Science and Art, &c. By John Timbs, F.S.A. London: Lockwood and Co., Stationers' Hall Court, 1863.

This Annual, always highly interesting, appears to us to possess this year a larger collectiou of interestiug scieutific jottings than any of its predecessors. The steel engraving of Sir Charles Lyell, D.C.L., is a life-like portrait of the illustrious Savau.

[We are reluctantly obliged at the last moment to omit several notices of books. Editor of The Artizan.]

NOTICES TO CORRESPONDENTS.

X.X.—The specimen of pig iron is of good quality, but it is evident that it would be improved by mixing with a good Staffordshire brand.

Hydraulic (Brazil).—Write to Mr. R. Roberts, C.E., of Adam-street, Adelphi, London, or send your name and address here, and we will obtain the information.

Alexis.—We must, uuder the circumstauces, decline to recommend any one.

D., S., & P.—Address the Seeretary of the Admiralty, Whitehall, London. You are all too young.

Superheater.—1. Do not waste your mouey ou the idea. It has already been pateuted four or five times. 2. How's Salinometer is, we believe, the best. 3. It is Messrs. Lamb and Summers (of Southampton) to which your third question refers. 4. Declined.

S.—"Swedish piston." We do not know of any locomotive piston known by this name. The buckets or Swedish pumps for mining and other purposes, are made up of < shaped pieces of bark, and work well. The woodeu pistons of the Swedish air blowing cylinders are built up iu pieces; each piece has a groove around it, having, however, no packing; the theory of its action being that before the emerging air passes from groove to groove, aud has reached the opposite side of the piston, is again on its return stroke, and the air is changed back again from grove to grove.

Mr. J. (Cauonbury).—Apply to Weale, Atchley & Co., and Spon the Engineering book sellers, for a catalogue of books ou railway construction.

R. H. T. (Newcastle).—1. We do not undertake to supply such information as you seek in detail, either in The Artizan or by letter. 2. As a rule it is better to address such questions to the author of a paper read at a Society, you are then pretty certain to get his own views. 3. We cannot find the figures quoted by you in our number for March, 1860. 4. The last edition of Bournes' works gives the most recent formulæ. 5. Read Mr. Atherton's paper iu The Artizan.

R. J.—Iu auswer to your inquiry with reference to the new bridge at Blackfriars we give the following:—

The designs for a grauite bridge were those submitted by—

Sir John Rennie, of three arches, the centre span being... 236ft. 10in.
Mr. George Reuuie, of five arches, the ceutre span being... 150ft.
This desigu appears to have been prepared in 1858.
Mr. George Rennie, of five arches, each span being .... 125ft.
Mr. R. W. Mylne, of five arches, the centre spau being ... 156ft. 6in.

The designs for a wrought-iron arched bridge were those submitted by—

Mr. Johu Fowler, of three arehes, the centre span being... 275ft.
Mr. Johu Fowler, of five arches, the centre span being ... 184ft.
Mr. John Hawkshaw, of three arches, the centre and other spaus being .... 200ft. each.
Mr. John Hawkshaw, of five arches, the centre and other spans being .... 145ft. each.
Mr. P. W. Barlow, of three arehes, the centre spau beiug... 250ft.

The desigu for a wrought-iron girder bridge was that submitted by—

Mr. R. P. Brereton, of five openiugs, the centre opeuing being .... 220ft.

The designs for a cast-iron arched bridge were those submitted by—

Mr. Thomas Page, of three arches, having a ceutre span of 280ft.
Mr. Thomas Page, of five arches, having a centre spau of 156ft.
Messrs. George P. Bidder and Edwiu Clark, of five arches, each span being .... 172ft.
Mr. George Reunie, of five arches, haviug a ceutre span of 160ft.
Mr. George Rennie, of five arches, having a centre span of 175ft.
Mr. George Rennie, of five arches, having a ceutre span of 180ft.
This design appears to have been prepared in 1852.
Mr. Robert William Mylne, of five arches, having a centre span of .... 163ft. 6in.
Mr. Joseph Cubitt, of five arches, having a ceutre span of 150ft.
Mr. James Brunlees, of five arches, haviug a centre span of 172ft.

The remaiuing design for an iron bridge was that submitted by—

Mr. Thomas Greeuhill, of seveu arches, having a ceutre span of .... 120ft.

with a tube for a railway; aud he mentions it may be converted into a five-arched bridge.

The "Flora" Iron Screw Steamer.—In the Artizan of December last, we gave an account of the trial trip of this steamer; and we are glad to learn that her performance at sea is also highly satisfactory. At the end of December the *Flora* made the voyage home from Madeira, under steam, in heavy weather, in $5\frac{1}{2}$ days. She was heavily laden, the screw heing 2ft. immersed. The *Flora* was chased on the voyage by the U.S. steamer *Tuscarora*, during a whole day, during which she encountered a strong N.E. trade wind, and a heavy sea. The *Tuscorora* being under sail and steam dead before the wind. The *Flora* succeeded in getting away from her pursuer and was making during this time 100 revolutions with steam at 17lbs. The *Flora* also, we understand, recently made the passage from Madeira to St. Thomas in 4 days, using alternate screws alternate days, making $7\frac{1}{4}$ knots with either screw.

Manganese in Iron.—It is well known that iron reduced from spathic ore, and other ores containing mauganese, not unfrequently contains a considerable percentage of manganese. In the variety of pig-iron called by the Germans Spiegeleisen (mirror-iron). the manganese has been estimated by different chemists to be from 4 to 7 per cent. In 1860, Dr. K. List published an analysis of a white-iron from Rüblinghausen, made from a mixture of ores containing from 20 to 25 per cent. of oxyde of manganese, in which he found but 3·80 per cent. of manganese. As the ore was so rich in manganese, List concluded that the iron obtaiued from its reductiou must contain the maximum amount of mangauese—that iron could not take up more than 3·80 per cent. manganese, and that the earlier analyses giving more than this must be iucorrect. (*Polytechnisches Journal* clv. 119.) Professor Richter, of Leohen, has, however, reviewed List's results, and shows that the differences in the manganese content of iron smelted at different furnaces, or at different times, does not necessarily depend upon the quantity of this substance in the ore, but upon the temperature of the furnace, and the relative amount of coal used in the reduction. The higher the temperature, and the larger the proportion of coal in the charge, the greater will be the relative amouut of manganese reduced. The basic or acid nature of the slag has also an important influence on the amount of the reduced manganese—it is easily reduced from a basic slag, but with considerable nifficulty, from an acid slag. Richter gives analyses of Spiegeloisen from Janerburg in Carniola and Theresienthal in Bohemia:—

	Jauerburg.	Theresienthal.
Sulphur	0·073	—
Silicon	1·902	2·732
Manganese	7·578	22·183
Carbon	—	2·311

The extraordinary amount of manganese found in the specimen from Theresienthal so influenced the properties of the iron, that it was not maguetic, and had not the power to throw down copper from a solution of chloride of copper; it simply reduced it to subchloride. Richter further remarks that the same mass of iron may contain more manganese in one part than another; this is duc to the tendency manganese has to separate from the fused mass, and the upper portion of a "pig" may thus contain more manganese than the lower portion.

Croll's Treatment of Ammoniacal Liquor of Gas Works.—Mr. A. Croll, of Coleman-street, proposes to avoid the inconvenience and annoyance arising from the treatment of ammoniacal liquor of gas-works in the following manner:—Steam from a suitable boiler is conveyed iuto ammoniacal liquor contained in a suitable closed chamber, and the combined vapour and steam resultiug are conveyed from the upper part of this chamber into other ammoniacal liquor contained in another closed chamber placed somewhat higher than the preceeding, in order that as the ammoniacal liquor in the previous chamber becomes spent it may be supplied from the second, and if desired other number of such ammouiacal chambers may be employed. From the last ammoniacal chamber the vapour resulting, combiued with particles of steam, is conveyed into a closed compartment or chamber of a vessel containing acid adapted to the salt of ammonia desired to be obtained. Thus, supposing the salt desired is sulphate of ammonia, theu the last chamber will contain sulphuric acid, and it is at its upper part divided into two compartments, one open at the top, the other closed by a cover, and a partition dipping below the surface of the acid liquid therein and below the mouth of the pipe conveying the vapour and steam thereto from the last ammoniacal chamber. Any vapour arising from the closed compartment of this vessel is couveyed into similar acid in another closed chamber used as a reservoir. From the upper part of this last closed chamber the sulphuretted hydrogen liberated is conveyed to the furnace supplying a vitriol chamber. By these means economy and the avoidauce or great mitigation of the inconvenience and annoyance arising from the treatment of the ammoniacal liquor of gas-works is secured.

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distiuct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Spencer v. Jack.—His Honour said that in this case a motion for a new trial of certain issues, directed by the Court, which resulted in favour of the plaintiff, had been made, and he considered the matter ot so much importance that he had taken time to look through the voluminous evidence which had been adduced ou both sides. The case was tried before the Lord Chief Justice of the Court of Common Pleas and a special jury, some time since, at Guildhall. The trial occupied three days, and the main question involved was whether a patent obtained by the plaintiff in the year 1860 for alleged "improvemeuts in steam engines, for propelling steam ships and other vessels," was a novelty and the proper subject of a patent. His Honour said he was sorry to say that he did not cousider the result of the last trial satisfactory to his own mind, and if the motion was pressed, he should feel bound to direct a new trial. A new trial was ultimately ordered.

Hyde v. Palmer.—This was an action tried in the Court of Queen's Bench on the 9th ult., aud was on a patent obtained by one Bersham in 1849 for improvements in separating the fibre from cocoa-nut husks. The plaintiff had become assignee of the patent, aud sued the defendant for the breach of it. At the trial before Mr. Justice Blackburn the novelty of the alleged invention was disputed on the grounds, first, that there had been previous patents by Logan and also by Berry. The jury at the trial found a verdict for the plaintiff. Mr. Hindmarsh, Q.C., subscquently obtained a rule for a new trial ou the ground of misdirection by the learned judge. Mr. Grove, Q.C., and Mr. Aston now appeared to show cause against the rule; and Mr. Hindmarsh, Q.C., and Mr. Raschet to support it. The Court made the rule absolute for a new trial.

Clare v. the Queen.—This was "a petition of right," the first tried under Bovill's Act. It was au action brought by Mr. J. Clare, jun., formerly a produce broker in Liverpool, and the patentee of certaiu "improvemeuts in the construction of iron houses, vessels, &c." The patent was dated the 5th September, 1853. The action was tried in the Queen's Bench, before Lord Chief Justice Cockburn, and a mixed special and common jury. The action was brought for the infringement of Clare's patent by the Admiralty in the construction of the *Warrior*, and some other iron vessels. The part of the plaintiff's invention, which he in particular complained had been infringed, was the use or employment of an independent framing, or structural arrangement of materials, in which vertical and longitudinal framing pieces were combined so as to form a stable structure, to which the plating was afterwards attached. The plaintiff now claimed to be compensated for the use of his plans, and so much of his invention as had been used by the Admiralty. The Admiralty resisted the claim, alleging that they had not infringed his patent, that the invention was not new, and that the patent was void. The case occupied the court five days, and notwithstanding the admirable manner in which the plaintiff's counsel conducted the case, the jury returned a verdict for the Crown, under the direction of the Lord Chief Justice.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Jonrnal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as tbeir interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of onr engineering brethren who reside abroad, we venture to make a suggestion to onr subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to ns. Those who cannot afford the time to do this would greatly assist our efforts by sending ns local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbonrs, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Browning Iron and Steel Objects.—Gun barrels and other objects in iron and steel are browned, either to improve their appearance, or to preserve them from rust, by giving them at first a thin but entire coating of oxide of iron. The following process is successfully employed in Prussia for browning steel barrels:—Dissolve two parts of crystallized ferric chloride, two parts of butter of antimony, and one part of gallic acid, in the smallest possible quantity of water (about four or five parts); with this moisten a sponge or cloth, and rub the object to be browned. Leave it to dry in the air, and repeat the operation several times. Then wash with water, dry, and rub with boiled linseed oil. Objects browned in this way have a very agreeable dead grey appearance, and the shade deepens according to the number of times the operation is repeated. It is essential to the success of the operation, that a solid butter of antimony be used,—that is to say, a chloride of antimony containing as little free hydrochloric acid as possible.

Dockyard Expenditure.—A blue book has been issued containing balance sheets showing the cost of manufacturing articles in the workshops of the several dockyards and steam factories for the year 1860-61. The dockyards and steam factories from which accounts are presented are Deptford, Woolwich, Chatham, Sheerness, Portsmouth, Devonport, and Pembroke. Taking the first table, under the head of mast houses, it will be found that in the year 1860-61, the total debit for these was £110,042 15*s.* 9¾*d.* The highest was Portsmouth, £44,051 8*s.* 4*d.*; the lowest Deptford, £178 7*s.* 3*d.* Devonport figures for £20,111 10*s.* 6¾*d.* In boathouses the expenditure is not very large, commencing with £2239 3*s.* 6*d* at Woolwich, and ranging to £7172 4*s.* 3*d.* at Portsmouth, Devonport coming in for £5351 19*s.* 3*d.* In capstan houses Chatham stands for the highest, £3782 16*s.* 8¾*d.*; Devonport comes next with £3084 18*s.* 7*d.*; Pembroke is the lowest, £521 7*s.* 5*d*, In joiners' shops Devonport stands first, £3976 4*s.* 7¾*d.*; Deptford is the lowest, £897 4*s.* 5*d.* From two of the dockyards, Deptford and Pembroke, no separate accounts were received from the plumbers' shops, and in none of the establishments from which these were sent was the amount large. At Chatham it was £3976 15*s.* 11¾*d.*; at Portsmouth, £53 6*s.* 11*d.* The total debit for wheelwrights' shops in all the dockyards was £1827 5*s.* 10¼*d.* Four of the dockyards spent £17,081 0*s.* 10*d*, in their millwrights' shops; three, Deptford, Woolwich, and Pembroks, send no return. This is the same in the roperies' department; hut in Chatham, Sheerness, Portsmouth, and Devonport, £371,671 5*s.* 0½*d.* was expended under this head. As in the joiners, here also Devonport takes the lead—£169,281 3*s.* 0¾*d.*, Chatham stands for abont £27,000 less; Portsmouth, £58,648 18*s.* 10*d*; Sheerness about one-fiftieth part of that sum An extensive business has been done in sail lofts: Portsmouth £17,260 16*s.* 9*d.*; Devonport about £1100 less; Pembroke the lowest, £66 14*s.* 2*d.* For colour lofts the total debit was £2299 14*s.* 2¾*d.* Devonport was the highest; Sheerness the lowest. Sheerness stands first in the rigging house department, Woolwich the last, the figures varying from £10,822 19*s.* 5*d.* to £16,131 5*s.* 10*d.* In the lead, paint, metal, and cement mills, the items are unimportant. Coming, then, to blacksmith's shops it will be found that there are returns from only Portsmouth and Devonport; the former £27,689 10*s.* 4*d.*, the latter £736 12*s.* 11½*d.* The expenditure in the trenail houses was small; Pembroke was the highest; Deptford the lowest; whilst from Portsmouth no account was received. Oarmakers' shops show a total of £6243 9*s.* 6½*d.*; from Deptford, Woolwich, Sheerness, and Pembroke, no returns were sent. For caulkers and pitch heaters the expenditure was £11,379 12*s.* 4*d.*; Portsmouth, £5959 1*s.* 6*d.*; Devonport, £2617, 14*s.* 2*d.* Passing over the turners' shops, which do not show for much, next is presented locksmiths', tinmen's and braziers' shops; these are somewhat over £2,000. The charge for foundries is scarcely what might have been expected—£5,082 4*s.* 9¾*d.*; from Deptford, Woolwich, Sheerness, and Portsmouth, there are no returns. For painting in the several dockyards, £5,170 3*s.* 7¾*d.* The only condensers' shop is at Portsmouth, where £15,831, 18*s.* 8*d.* was expended; here, also, is the only pnmp honse, which goes down for £840 10*s.* 0¾*d.* The only dockyard from which a fire-engine acconnt was received was Devonport, where the expenditure was £145 6*s.* 4*d.* "Smitheries" is a heavy item, no less than £211,606 18*s.* 5½*d.* being put down for them. Of this, £55,000 was spent at Portsmouth; £49,000 in the north and south smitheries of Devonport; £32,000 at Chatham; £27,000 at Woolwich; £18,000 at Sheerness; £14,000 at Deptford; and £13,000 at Pembroke. In steam-hammer shops, Portsmouth stands for £13,302 16*s.* 1*d.*; Devonport, £11,089 12*s.* 7*d.*; Deptford, £3102 9*s.* 7*d.* At Portsmouth, nearly £7000 was expended in the iron-foundries, and at Keyham £1481 14*s.* 6*d.* Brass-foundries—Portsmouth, £45,522 12*s.* 7*d.*; Keyham, £13,474 12*s.* 6*d.* Copper-smiths' shops—Portsmouth, £4851 19*s.* 10*d.*; Keyham, £1234 17*s.* Engine Smitheries—Portsmouth, £5850 15*s.* 4*d.*; Keyham, £5659 10*s.* 3*d.* Boiler smitheries—Keyham, £5394 9*s.* 10*d.*; Portsmouth, £5148 8*s.* 4*d.* The total expenditure in the dockyards for the year 1860-1 was £1,362,505 3*s.* 8*d.*; and in addition to this, under the head of shops in the steam factories, there is £144,881 3*s.* 4*d.*

The Navy Estimates.—The estimate of the sums required to meet the expenses which may be incurred in the naval department in the year 1863-64 has recently been issued, and is as follows:—The total amount required for the naval service is £10,465,882, whilst for the financial year 1862-63 it was £11,605,655; and for the army department (conveyance of troops), the amount required for the current year is £270,150, against £188,650 for the past year, thus showing a net decrease of £1,058,273.

New mode of Generating Steam.—Mr. J. L. Linton, a gentleman from America, has lately visited Paris for the purpose of submitting to the French Government his new method of generating steam. Instead of the ordinary fuel he uses petroleum oil; or, should that be wanting, ordinary coal oil; and, as the machinery which he employs can he easily applied to the steam engines in general use, he claims tbe merit of effecting a very considerable saving. It is reported tbat this plan has been examined by a Government Committee in Paris.

A New Petroleum Trading Company is announced, witb a capital of £100,000, in shares of £10 each. The object is to import petroleum from the natural wells in America, in iron tank vessels specially constructed, which vessels will class A1 for 17 years. By this proceeding a large per centage will be saved in freights. The demand for petroleum is yearly increasing for lighting purposes, and it is a cheap and efficient agent for the rapid generation of steam.

Voltaic Batteries for Steamers.—The Emperor of the French is superintending the construction of one of three batteries, intended to replace fuel. In tbis conntry it has been proposed to our Admiralty to make a trial of a voltaic battery of 2000 double plates, each containing 30 square inches, the wbole surface being 128,000 square iuches. Charcoal points, connected with tbe two poles, are ignited to whiteness, on withdrawing the points from each other, an arch of light, 4in. in length, is produced between them. When any substance is introduced into this arch, it instantly ignites. Platinum melts as readily as wax in a common candle. Quartz, the sapphire, &c., with equal facility.

Barometer for Measuring Atmospheric Disturbances.—At tbe last meeting of the Manchester Literary and Philosophical Society, Dr. Joule described a barometer for measuring small atmospheric disturbances. It consists of a large carboy connected by a glass tnbe with a miniature gasometer formed by inverting a small platinum crucible over a small vessel of water. The crucible is attached to the short end of a finely suspended lever multiplying its motion six times. When the apparatus was raised two feet the index moved through one inch; hence he was able in the serene weather to observe the effect corresponding to the elevation of less than one inch. The barometer is placed in a building, the slated roof of whicb affords, without perceptible draught, free communication with the external atmosphere. In this situation it was found that the slightest wind caused the index to oscillate, a gale occasioning oscillations of two inches, an increase of pressure being generally observed when the gusts took place.

Shipbuilding on the Clyde.—The number of iron ships built on the Clyde, duriug tbe last seven years, has been as follow:—

Year.	Ships finished.	Tonnage.	Builing at close of year.
1856	102	58·530	62
1857	98	57·416	56
1858	60	40·922	34
1859	78	35·705	52
1860	88	47·833	46
1861	88	66·801	62
1862	122	69·969	86

Private Bills.—The Speaker laid upon the table of the House of Commons, on the 20th ult., a report from the Examiners of Petitions for Private Bills, that in respect of the bills comprised in the list reported by the Chairman of Ways and Means as intended to originate in the House of Lords, they have certified that the Standing Orders have been complied with in the following cases:—Albert Bridge; Anglesey Central Railway; Banff, Macduff, and Turriff Extension Railway; Banff, Portsoy, and Strathisla Railway; Barnes, Hammersmith and Kensington Railway; Bishops Waltham Railway; Blackburn, Chorley, and Wigan Railway; Buckley Railway; Carmarthen and Cardigan Railway (No. 1); Carmarthen and Cardigan Railway (No. 2); Carnarvonshire Railway: Cork and Kinsale Junction Railway; Cowes and Newport Railway; Dare Valley Railway; Dublin Metropolitan Railway; Dulas Valley Mineral Railway; Dundalk, Carlingford, and Greenore Railway; East Gloucestershire Railway; East London and Rotherhithe Railway; Edinburgh Water; Esk Valley Railway; Fochabers and Garmouth Railway; Fulham Bridge: Grand Surrey and Commercial Docks Railways; Great Eastern Railway (New Metropolitan Station and Branches); Great Eastern Railway (Steam-boats); Great Grimsby Water; Greenock and Wemyss Bay Railway; Hammersmith and City Railway; Hoylake Railway; Ilfracombe Railway; Irish North-Western Railway; Isle of Wight Railways (Extensions); Lands Improvement Company; Launceston and South Devon Railway; Law Life Assurance Society; London, Chatham, and Dover Railway (No. 1); London (City) Traffic Regulation; London Railway (Victoria Section); Londonderry Railway (Seaham to Sunderland); Lowestoft Water, Gas, and Market; Merthyr, Tredegar, and Abergavenny Railway; Metropolitan Bridges; Metropolitan Railway; Metropolitan, Tottenham, and Hampstead Railway; Newry and Greenore Railway, Pier, and Wet Dock; North British Railway (Steam-boats); North London Railway; Northumberland Central Railway; Okehampton and Lidford Junction Railway; Pontypridd Water; Putney and Fulham New Bridge and Pier; Ringwood, Christchurch, and Bournemouth Railway; Ripley's Hospital; Rotherhithe Railway; St. Ives and West Cornwall Junction; Sidmouth and Budleigh-Salterton Railway; Solicitors' and General Life Assurance Society; South London and Greenwich and Woolwich Railway; South London Market; Stokes Bay Railway and Pier, and Isle of Wight Ferry Companies; Surrey Gas; Thames Bridges; Tottenham and Hampstead Junction Railway; Uxbridge and Rickmansworth Railway; Van Diemen's Land Company; Victoria Station and Pimlico Railway; Watford and Rickmansworth Railway; West Cork Railways; West London Docks and Warehouses; West London Extension Railway; Wicklow Copper and Hibernian Mines Companies; Yarmouth Gas. The standing orders have not been complied with in the following cases, viz.:—Cardiff, Caerphilly, and Aver Valley Railway; Cardiff and Caerphilly Railway; Cardiff Consumers' Gas; Colne Valley and Halstead Railway; Cookstown and Pomeroy Railway; Corris, Machynlleth, and River Dovey Tramroad; Morayshire Railway; Putney, Balham, and City Junction Railway; Rumney and Brecon and Merthyr Tydfil Junction Railways; Sligo and Ballaghaderreen Junction Railway; South Mayo Railway; Wandsworth and Fulham Bridge; Wexford and Enniscorthy Railway.

Trial of a New Traction Engine.—On the 21st ult., a number of engineers and scientific men assembled at Rochester for the purpose of witnessing some experiments made with a new traction engine, manufactured by the firm of Messrs. Aveling and Porter, of Rochester, the patentees. The engine selected for the trial was one of several which are now being manufactured for the Yudanamutana Copper and Mining Company, Australia. Shortly after 1 o'clock the engine started from the factory at Strood with four heavy waggons attached, each laden with baulks of timber, the total weight of each wagon, with its freight, being close upon five tons. With this load the engine traversed the narrow streets of Strood, turning the sharp angle at the turnpike and ascending a long incline of about 1 in 12, for upwards of a mile, at a speed of five miles an hour. The engine was then turned towards a hill with a rise of 1 in 8—the steepest of the kind in the neighbourhood—and, notwithstanding the exceedingly soft, sloppy state of the road, ascended to the top with the train of waggons at the rate of about three miles an hour. After travelling some distance at speeds varying from three to six miles an hour, the engine and train descended the long inclines, and again reached the turnpike roads, where two more heavily laden waggons were attached, swelling the weight, with the engine, to upwards of 40 tons. Again the engine was started, and, without the least apparent difficulty, it dragged its load over every variety of ground and through the streets, arriving at the factory at about 5 o'clock, after an absence of upwards of three hours. The engine experimented upon was one of nominally 10-horse power, and was the first traction engine which ever ascended a gradient of the steepness of that passed over on this occasion with such a heavy weight. It is the intention of the company to send out 20 similar engines to Australia for the purpose of transporting the copper from their mines to the port, a distance of 120 miles, over an unbeaten tract of land. The cost of carriage is now £10 per ton, but by the use of these engines it will be reduced to £2 per ton.

Semaphores.—M. Felix Julien publishes an article on the semaphores now established or in course of construction along the coasts of France. Their number is upwards of 150; each consists of a small white house roofed with red tiles, and surmounted by a tower. From this there rises a vertical mast, 10 metres in height, provided with three moveable fan-shaped wings, by means of which signals are made to ships passing even at a distance of six miles. The ship replies by its flags, and thus news may be instantly transmitted from the vessel to any part of the country, thanks to the telegraphic wire with which each semaphore is now provided. The semaphore is essentially an instrument of attack or defence in times of war; but even during peace time it may perform valuable service, if, as M. Julien justly suggests, its communications of the state of the weather be received at a central office, established at Paris, and thence made to radiate to all the points of the French coast—a plan perfectly in accordance with that now conducted in England by Admiral Fitzroy. The signals used by French vessels for great distances consist of the three primitive figures of geometry, viz., a square or ordinary flag; a triangle or flame; and a circle, or ball. The combination of these three signals taken two by two, gives the first ten figures of our numeral system; which may be combined so as to express any number between 1 and 10,000. This is, indeed, the number of articles contained in the French code of signals for the mercantile navy. The semaphore replies to these signals by its three wings, each of which can assume six different positions. Each of these positions represents one of the first six numbers. The first wing represents the units, the second the tens, and the third the hundreds. But to render the system more simple, the semaphore first telegraphs the page of the signal-book, and then the line of the page separately.

The Pneumatic Dispatch.—The Postmaster General and the Secretary to the Post Office, have officially inspected the working arrangements of the branch tube from the Euston Station to the North-Western Post Office in Eversholt-street, previous to the transmission of the mails between these two places; the Post Office authorities having conceded this privilege to the Pneumatic Dispatch Company. After the working arrangements had been fully explained, trains of cars were rapidly propelled backwards and forwards through the tubes, the cars containing heavy weights; being principally loaded with stout planks, and on the signal being given by Wheatstone's telegraph, they were despatched to the other end of the tube with a pressure of about 4 ounces, in a few seconds over a minute; the average up the incline being about 1 minute 12 seconds, returning by vacuum in 1 minute 5 seconds. The mail bags, upwards of 120 per day, will be blown through the tube in 55 seconds, to the Post Office, Eversholt-street; the usual time occupied by the mail carts being at present about 10 minutes. The next step of the company will be to lay tubes connecting the markets of London with the Camden Goods Station, with a tube to the General Post Office, and Pickford's depôt in Gresham Street.

Trial of New Iron Sheers.—On the 11th ult. a number of gentlemen assembled in the Southampton Docks, for the purpose of witnessing the tests applied to the monster iron sheers just erected for the company, under contract, by Messrs. Day and Co., of the Northam Ironworks. They are of the following dimensions:—Length of the front legs, 110ft.; length of the back leg, 140ft.; power of the engine to work them, 20 horse-power; proof strain to be 100 tons, vertical lift, and 80 tons with an overhang of 35ft. from the dock wall. The enormous bundles of rail iron, forming the testing weights of 100 tons, were raised from the railway trucks, which run under the sheers, and deposited on the quay; after which 80 tons were lifted and run out 35ft. from the dock wall, and brought back again in a remarkably quick and satisfactory manner. This is effected by an improvement introduced by Mr. Thomas Summers, of the above named works, in the construction of sheer legs, which renders them simpler and more easy to work than those on the ordinary plan. In the new sheers the back leg is made to act both as a prop and a guy to the front legs, and its bottom end slides in an iron groove strongly bolted to its foundation. The movement of the back leg along this groove is affected by a powerful wrought-iron screw, 43ft. long and 8in. diameter, and worked by the same engine as is used to work the hoisting gear. The length of the groove is 48ft., and the sheers are run either in or out in about four minutes. The rate of hoisting for weights up to 20 tons, is about 12ft per minute, and for heavier weights a more powerful purchase is used, giving a rate of from 4ft. to 6ft. per minute.

NAVAL ENGINEERING.

Trial of the Lyrian, Screw Gunvessel.—The *Lyrian*, commenced her official trials of speed at the measured mile in Stokes Bay, on the 27th January last, and completed them on the following day. The *Lyrian* is one of the new description of gunvessels, of an intermediate size, between the small Haslar class and the despatch boat. She is fitted with engines of 60 horse-power, nominal, by Messrs. Maudslay, on the high-pressure principle; but since her completion, a condenser has been added by the Admiralty Department. She has a Griffiths screw of 8ft. pitch, and 8ft. diameter, working with a draught of water in the ship's hull of 8ft. aft. and 7ft. 6in. forward. On the first day the trials were at high pressure. The wind was at a force of about 4, and in a W.N.W. direction. Six runs were made with the following results:—1st, 6·371 knots; 2nd, 10·055 knots; 3rd, 6·509 knots; 4th, 10·198 knots; 5th, 6·070 knots; 6th, 9·863 knots: thus giving a mean speed of 8·214 knots; the average pressure of steam was 60lb.; and the average number of revolutions, 165. On the second day the low-pressure trials were made at the measured mile. The weather was unusually favourable for the time of year. The first trials were made with six runs at full power, as follows:—1st, 7·438 knots; 2nd, 8·695 knots; 3rd, 7·531 knots; 4th, 8·780 knots; 5th, 7·438 knots; and 6th, 8·845 knots; giving a mean speed of 8·120 knots; average pressure of steam 38lb.; revolutions of engines 152. One boiler out of the two with which the ship is fitted was next cut off, and six runs made with one boiler, yielding results as follows:—The 1st, 5·825 knots; 2nd, 7·114 knots; 3rd, 5·598 knots; 4th, 6·593 knots; 5th, 5·891 knots; and the 6th, 5·479 knots, giving a mean speed of 6.192 knots; the average pressure of steam, 37lb., and the average number of revolutions, 121. In testing the mechanical working of the engines, they were stopped dead from the time of giving the signal in 9 seconds; they were started ahead in 8 seconds, and turned astern in 3 seconds. The trial of the *Lyrian* was considered most favourable. The chief novelty connected with the engines of the *Lyrian*, consists in her being fitted with two short boilers, with return tubes, taking up less space than the ordinary mode of gunvessel fitting, steam being got up in less time, and also kept up with greater ease to the *maximum* point.

The "Emerald," screw frigate of 34 guns, 2913 tons, and 600-horse power, Captain Arthur Cumming, commenced her series of experimental speed trials with various forms of screw propellers, at Portsmouth, on the 19th ult. The trials will be conducted by Captain H. Broadhead, commanding her Majesty's ship *Asia* and the reserve at the port, and his staff will consist of Mr. Ward, Assistant Engineer of the dockyard, and Mr. Murdoch, the Inspector of Machinery of the Steam Reserve. The following were the results of the trial:—No. 1 trial.—Screw, common Admiralty pattern, with a diameter of 18ft., a pitch of 28ft., and a length of 3ft. 6in.; the leading corners of the screw cut. The ship drew 21ft. of water forward and 22ft. aft. Coals on board, 300 tons; state of weather, a calm. Runs:—1st run, time, 5 min.; speed in knots, 12·000; steam, 20lbs.; vacuum, 24; revolutions, 53·5; 2nd run, time, 5 min. 29 sec.; speed, 10·942; steam, 18½; vacuum, 24; revolutions, 53·5; 3rd run, time, 4 min. 46 sec.; speed, 12·587; steam, 18; vacuum, 24; revolutions, 53·5; 4th run, time, 6 min. 3 sec.; speed, 9·917; steam, 19; vacuum, 24; revolutions, 54; 5th run, time, 4 min. 31 sec.; speed, 13·284; steam, 19½; vacuum, 24; revolutions, 54; 6th run, 6 min. 8 sec.; speed, 9·783; steam, 19½; vacuum, 24; revolutions, 54·5. The mean speed of the ship is 11·529 knots. The circles were made:—Port—half circle, 4 min. 22 sec.; full circle, 8 min. 40 sec.; starboard, half circle, 4 min.; full circle, 8 min. 29 sec.; port—helm put up in 19 sec.; starboard, 18 sec.; port—angle of under 15 deg., starboard, 16 deg.; port—turns of wheel, 1¼; starboard, 1¾; port revolutions of engines, 51·5; starboard, 52. There were six men at the wheel. It is intended to carry an uniform "pitch" of the screw throughout. The *Emerald*, on the 21st ult., resumed her experimental screw trials. The screw tested on this occasion was of the same pattern as on the last, the common, or Admiralty screw, with an increasing pitch of from 27ft. 6in. to 29ft. 6in.; diameter, 18ft.; length, 3ft. 6in.; and immersion, 10½in. Six runs were made at the measured mile, the mean of the whole giving the ship a speed of 11·524 knots, with a mean revolution of engines of 53. The ship turned a full circle to port in 8 min. 49 sec., and to starboard in 10 min. 1 sec.

The "Royal Sovereign."—On the 14th ult. Lord Clarence Paget arrived at Portsmouth, and visited the *Royal Sovereign*, converting to a turret ship in the dockyard, under the direction of Capt. C. P. Coles, R.N. Six of her armour plates, three on each side, are being bolted on, and, so far as the external work of the ship's conversion is concerned, she is now ready to receive the whole of her armour plating from below her water line to her topsides. To receive this part of her armour the ship has been strengthened outside with two layers of diagonal teak planking, the inner being of three and the outer of four-inch. This diagonal strengthening extends 11ft. 8in. below that part of her topsides to which she was originally cut down. The lower ends of this diagonal planking rest in worked rabbits of longitudinal planking added to the original bottom of the ship, which project sufficiently far beyond the level of the diagonal ends to form a shelf on which will rest the lower edges of the lower tier of armour plates. The lowest part of this longitudinal planking is 14ft. 10in. from the point to which the ship was originally cut down. The ship was cut with a sheer forward and aft, which Capt. Coles afterwards disapproved. The result was that the ship's topsides were filled in and raised, the greatest extent being amidships, where it is about 18in. Sloping downwards from the centre in all directions, to allow of the required depression of the guns in the turrets, the appearance of the *Royal Sovereign's* upper deck, when complete, will be as nearly as possible like the under part of a butcher's tray, thus forming the glacis of the gun towers or turrets. Where the towers stand, or rather are to stand, the original wooden beams have been removed, and their places taken by short rolled-iron beams from the Butterly Works, which extend from the ship's side to the crown of the glacis at its junction with the tower. Where the removal of the original beams has not been necessitated by the fitting of the towers they have been retained, and to give the necessary slope outwards to the deck they have been doubled over by other beams. As an instance of the size of and distance between the beams thus doubled over, it may be mentioned that the beams forward of the foremost turret and abaft the aftermost one are 3ft. 3in. in depth and 1ft. 5in. in width, of solid timber. Six of these double beams, in addition to massive inner strengthenings, are between the vessel's stern and forward turret, the distance between each beam being about 2ft. 4in. Amidships the beams are even closer, and are alternated with rolled-iron beams secured to longitudinal iron beams, clear of the turrets amidships, where not extending right acsoss the deck, by stout U-shaped knees. The height of the original wooden beams from the deck below is exactly 6ft., but where the old wooden beams have been removed altogether and short iron ones substituted, as in the make of the turrets, an additional height is gained of 18in. at the combings of the hatchways and 14in. in at the ship's side. The *Royal Sovereign* has not been built expressly for a turret ship, and therefore, when tried, allowances must be made for certain qualifications which she will possess and which she would have done much better without. The Admiralty have also decided that she is not to be masted, and consequently she will be unable to steady herself at any time by her canvas. With all the faults that can possibly be summed up against her, the *Royal Sovereign* will solve the problem as to whether guns of much heavier calibre can be worked better on the central than on the broadside principle,—in fact, whether a gun of 20 tons cannot be worked more efficiently and with greater ease from a turret, than a gun of 7 or 8 tons can ever be expected to be worked through a broadside port. The water was, on the 20th ult., admitted into No. 3 dock at Portsmouth, and the *Royal Sovereign* was floated off her blocks. On the water rising in the dock to a sufficient height, the ship was lifted off her blocks at a draught of 13ft. 8in. forward, and 17ft. 5in. aft., the water line being just below the lower portion of the added longitudinal planking which supports the 7in. of crossed diagonal teak planking which has been added to the ship's external topsides to strengthen her, and assist in carrying her 5½in. armour plates, and also supports in a rabbit the lower edges of the bottom tier of armour plates. At this draught of water, therefore, the embryo turret-ship was floating, the only weights in addition to the wooden hull being her machinery complete as an 800 horse power screw steamship, ten of her huge 5½in. iron armour plates on her sides partially completed in their bolt fastenings, and 30 of the 1in. iron plates on the upper deck beams underneath her 8in. wooden deck planking, which lay on the beams of her upper deck. In measuring round her topsides to ascertain their exact height from the water line, it was found to be as follows:—Amidships, 15ft. 2in., on the quarters, 15ft. 5in.; and on the bluff of the bows, 16ft. Her estimated draught of water when ready for sea, with everthing on board, is 20ft. 3in. aft, and 21ft. 9in. forward, which leaves, at the ship's present draught, an additional immersion of the hull of 7ft. aft and 6ft. 4in. forward, to carry the undoubtedly enormous weight which has yet to be put on and into the ship. This weight will be comprised chiefly in the following items:—Four turrets of 80 tons each, 320 tons; armour for sides, fastenings, and deck-plating, 1000 tons; anchors 27, and cables 72 tons, 99 tons; messengers and fittings, 6 tons 13 cwt.; boats, 12, and firehearth 8, 20 tons; men and effects (280), 44 tons; boatswain's and carpenter's stores, 85 tons; armament, say (what it ought to be), 100 tons; shot, shell, and gunner's stores, 170 tons; powder, 30 tons; water and tanks, 30 tons; coals, 600 tons; and provisions and victualling stores, 72 tons. The whole weight will thus be 2576 tons 13 cwt. There are the steam capstans, auxiliary engines for working them, the internal fittings of the ship, and many other smaller items, all amounting to a goodly total, that are not included, of course, in the above, but which will materially add to the weight to be carried by the turret-ship. The extra displacement the ship will gain by her increased section from her diagonal and longitudinal planking and armour-plating to 5ft. below her water line, will of course give her additional carrying power; but this will, no doubt, injuriously affect her speed, not only by the increased size of the hull to be driven through the water with a given power, but also by all want of relative proportions in the bottom of the hull, owing to the abrupt ending of the additional planking at between 7ft. and 8ft. below the line of flotation.

Trial of the "Leander."—This screw frigate, 2760 tons, 400 porse-power, was taken to the measured mile, on trial of her machinery and engines, on the 4th ult.; but owing to the excessive priming, she was unable to complete her trial. Since then her boilers and pipes had undergone a thorough overhauling and cleaning, and the vessel was again taken out on trial on the 17th ult. During the period of four runs the trial was successful, the engines working satisfactorily, with an entire absence of hot bearings. The average speed attained in the four runs was 10¾ knots, with 60 revolutions per minute vacuum, 18½; mean pressure of steam, 23lbs. While the fifth run was being made, the padding in the junctions of the relief valve, which it is thought had become decayed, was forced out of its place, and, owing to the excessive leakage, the trial had again to be postponed.

The "Caradoc," paddle-wheel despatch, has returned to Woolwich from an engineer's trial of her machinery, after repairs. The trial was prolonged beyond the usual test, in order to ascertain the merits of Mr. Humphrey's new superheating steam apparatus, fitted to the boilers. The maximum speed attained by the engines of the *Caradoc* was only 10½ knots per hour; becoming overheated, the apparatus burnt away a portion of the woodwork before the foremost funnel.

TRIAL OF THE "HIMALAYA" TROOPSHIP.—The *Himalaya*, screw troopship, 700 horse power, on the 2nd ult., made her official trial of speed, on the conclusion of extensive repairs to her machinery, at the measured mile in Stokes Bay. The weather was most unfavourable for developing the ship's highest rate of speed, a strong south-west gale blowing at the time. Four runs were made with full boiler power, the mean of which gave a speed of 11·88 knots. Two runs were next made with half boiler power, giving a mean speed in knots of 9·550. The maximum number of revolutions of the engines was 58, and the minimum 55; the propeller being a Griffiths, having a diameter of 18ft., a pitch of 27ft. 9in., and an immersion of its upper blade of 4ft.

THE "ALFRED."—This iron screw turret-vessel, building for the Government at Messrs. Samuda's, in their yard at Blackwall, is making rapid progress. Her armament, consisting of five deck guns only, will be protected by four cylindrical armour-plated turrets, three of which will contain a single gun each, and the fourth two guns, making the total amount of her armament. The construction is exactly that of the Confederate invention, and is intended for similar purposes. The turrets will be built up after the principle of the *Warrior's* sides, with 4½in. plates, backed by solid teak timbers. The revolving platforms and general woodwork of the turrets have been cut out and the work commenced by the shipwright department at Woolwich.

THE "CALEDONIA."—The plating of this vessel is advancing rapidly in dock at Woolwich. A new system practised in armour-plating the ships of the French navy has been introduced, which it is expected will have the effect of warding off the dry rot, and preventing decay. It is effected by carbonising with a flame of gas the surface of the timber before receiving the plates. In order to obtain a satisfactory test of the effect of this system, an equal number of the plates has been laid on without the carbonising, and the system will be applied to the remainder of the strakes to obtain the necessary result.

THE BRITISH NAVY.—A return issued on the 16th ult. gives in detail the number of steam ships afloat and building, together with the number of effective sailing ships, on the 1st February, 1863. There were then afloat a total of 522 vessels, of which 414 were screw and 108 paddle. There were building 44, and of effective sailing ships afloat the number was 103—grand total, 669. Of the ships afloat 2 are armour-plated (iron) second rates; and 3 armour-plated (iron) third rates; and 3 are armour-plated (wood) third rates. There were 56 screw ships of the line afloat, and 38 screw and 16 paddle frigates; 25 corvettes and 65 sloops; 7 floating batteries, 209 gunboats and gunvessels; the remainder of the ships afloat carrying smaller armaments. There are building 8 armour-plated ships, of which 4 are iron second rates, 1 iron third rate, and 3 wood third rates. There are also 2 turret ships in progress, third rates, 1 iron new, and 1 wood converting. The building of 3 ships of the line, and 6 frigates, 4 corvettes, 5 sloops, and 6 gunboats, all screw, is suspended. Of the effective sailing ships afloat 9 are screw ships of the line, and 13 are frigates, 7 are sloops, and 73 mortar vessels and floats.

NAVAL FORCE.—The number of 76,000 men to be voted for the navy is made up thus:—5784 officers, subordinate officers, and warrant officers; 33,216 petty officers and seamen, 9000 boys, 9000 Coastguard, 1000 officers and men employed in the Coastguard Civil Service, and 18,000 marines. The Estimates propose £40,000 for Royal Naval Coast Volunteers and for victualling and clothing them when afloat, provision being made for 8000 in number. The sum to be voted for the Royal Naval Reserve is £193,060; the provision is made for 16,000. The ships in commission on the 1st of December were as follows:—Line-of-battle ships, 13; iron-cased ships, 4; frigates and corvettes, 46; sloops, small vessels, and gun-boats, 92—making in all 155 sea-going steam vessels, being 5 less than on the 1st of December, 1861. The guard-ships, stationary ships, surveying, troop, and store ships, and tenders, brought the total fleet and Coastguard up to 90 sailing and 237 steam vessels on the 1st of December last, a number 10 less than on the 1st of December, 1861.

IRON MORTAR VESSELS.—Admiralty orders have been received at Chatham for another of the fleet of mortar vessels laid up in Yantlett Creek to be handed over to the Controller of the Coastguard for use in that service, the Admiralty having determined on bringing the whole fleet of mortar-boats into use as opportunities occur, instead of allowing them to remain rotting in inactivity at their present berths. Beside the numerous mortar-vessels at Yantlett Creek, there is likewise a large squadron of iron mortar-boats, built during the Russian war, laid up at Chatham Dockyard, costing the country a considerable sum to keep them in repair, and to prevent rust eating into their iron plates. Each vessel is housed over with a covering of wood to protect it from the weather, but, although every precaution is adopted in this respect, nothing can prevent their undergoing a certain amount of injury. The number of these iron mortar-vessels cannot be much less, if it does not exceed, 100.

STEERING BY TELEGRAPH.—The iron-cased frigate *Royal Oak*, 34, 800 horse-power, preparing for sea at Chatham, has been selected by the Admiralty as the first vessel in the navy on board which Gisborne's code of steering and engine-room electric telegraph signals are to be fitted. Since the former order for applying the invention to the *Royal Oak* was issued a second Admiralty order has been received at Chatham dockyard directing the steering signals in addition to being placed in the engine-room and on deck, to be fitted within the armour-plated turret which is now being erected on the upper deck, and also to the two lower deck wheels, thus enabling the officer stationed within the turret to communicate his orders simultaneously to the engineer and also to the men at the wheel. This arrangement is most important. During intricate navigation, such as entering or leaving harbour, or in foggy or stormy weather, it is frequently of vital importance that the captain's orders should be conveyed quickly and unmistakably to the helmsmen and engineers, and the invention enables every movement of either the helm or the engines to be apparent to the commanding officer.

THE SPANISH FLEET.—The following is a list of the Spanish frigates now afloat or building:—Screw Ironsides. *The Sagunto*, 30 guns; *Zaragoza*, 30; *Humannia*, 40, all building; *Arapites*, 30; *Navas de Tolosa*, 50; *Gerona*, 50; *Principe de Austerias*, 50; *Principe Alfonso*, 30; *Victoria*, 30. Screw steamers; *Villa de Madrid*, 50, building *Almansa*, 50. Sailing vessels: *Espenanza*, 42; *Triumfo*, 42; *Resolucion*, 42; *Nuestra*, 42; *Senora del Carmee*, 42; *Lealtad*, 42; *Concepcion*, 38; *Beranguela*, 38; *Blanca*, 38; *Petronilla*, 38. Of the ten corvettes in the Spanish navy, five are sailing vessels, and five screw. Of the 22 goelettes, only one is a sailing vessel, the others are screws, seven of which are building.

NAVAL APPOINTMENTS.—The following appointments have taken place since our last:—H. W. Elgar, Chief Engineer, to the *Buzzard*; J. Nell, Chief Engineer, to the *Cumberland*, for the *Mars*; J. Walsh, Engineer, W. Nicholson, First-class Assist. Engineer, and J. G. Sampson, Acting Second-class Assist. Engineer to the *Buzzard*; T. S. Gissing, First-class Assist. Engineer, to the *Asia*, for the *Foam*; D. Langlands, First-class Assist. Engineer to the *Caradoc*; T. Harker, in the *Foxhound*, promoted to Acting First-class Assist. Engineer; W. Tempest, Second-class Assist. Engineer, to the *Fisgard*, for the *Baun*; H. H. Tomkin, promoted to Chief Engineer; J. Staley, First-class Assist. Engineer, to the *Asia*, as supernumerary; M. A. Fothergill, Acting Second-class Assist. Engineer, to the *Cumberland*; J. W. Carpenter, in the *Firefly*, promoted to Acting Chief Engineer; J. Lawson, Engineer, qualified for charge, to the *Racoon*; W. White, supernumerary, in the *Cumberland*, promoted to First-class Assist. Engineer; S. J. Bird, and W. Hay, Second-class Assist. Engineers, to the *Racoon*; T. H. W. Ramsay, Acting Second-class Assist. Engineer, to the *Indus*, as supernumerary; A. Clarke, in the *Defence*, promoted to Engineer; H. Woolley, Engineer, to the *Indus*, for the *Alert*; J. Murdock, Acting Second-class Assist. Engineer to the *Asia*, as supernumerary; C. Ieely, Chief Engineer, to the *Fisgard*, for the *Caledonia*; J. Gillies, Chief Engineer, to the *Cumberland*, for the *Scylla*; J. Francis, in the *Shannon*, J. Purdie, in the *Petrel*, J. Russell, in the *Fisgard*, and W. Kelly, in the *Satellite*, promoted to First-class Assist. Engineers; C. M. Johnson, in the *Forte*, J. Gibson, in the *Firefly*, A. Templeton, in the *Euryalus*, G. Whitting, in the *Ardent*, W. Taylor, in the *Barracouta*, and W. Brock, in the *Alacrity*, promoted to be Acting First-class Assist. Engineers; J. Copplestone, Acting Second-class Assist. Engineer, to the *Indus*, as supernumerary; G. Booth, Engineer, and J. Russell, First-class Assist. Engineer, to the *Racoon*; W. R. Leeson, in the *Snake*, promoted to Acting Engineer; J. C. Gray, First-class Assist. Engineer, to be borne supernumerary of the *Fisgard* from the date of his arrival in England; W. Gair, in the *Stromboli*, promoted to Acting First-class Assist. Engineer; J. A. Lodge, Engineer to the *Fisgard*, as Supernumerary; W. Tempest, in the *Fisgard*, for the *Baun*, and G. Murray, in the *Asia*, promoted to First-class Assist-Engineers; W. H. Brunfield, Acting First-class Assist. Engineer to the *Fisgard* as Supernumerary; J. A. Cawlay, Second-class Assist. Engineer, to the *Cumberland*, as Supernumerary; A. M. Boumage, J. W. Haves, G. J. Weeks, W. T. Pover, and G. H. Barnes, Acting Second-class Assist. Engineers, to the *Asia*, as Supernumeraries; S. J. Rock, Acting Second-class Assist. Engineer, to the *Narcissus*; F. Brockton, T. Clark, W. Gentles, and J. F. Hughes, Engineers, to the *Vigilant*; J. Knight, Engineer, to the *Cumberland*, for the *Cochin*; W. W. Williamson, promoted to be Inspector of Machinery afloat; P. Steel and R. J. Hay, Chief Engineers, to the *Cumberland*, for the *Atlas* and *Bristol* respectively; J. F. Channon, Engineer, to the *Indus*, as Supernumerary; T. Rose, First-class Assist. Engineer, to the *Indus* for the *Fervent*; M. J. Sprake, Acting Second-class Assist. Engineer, to the *Asia*, for the *Frederick William*; S. Swan, Engineer to the *Victory*, for the *Sprightly*; R. E. Davison, in the *Petrel*, promoted to Engineer; W. B. Trenwith, Second-class Assist. Engineer, to the *Megara*; W. Crichton, Acting Second-class Assist. Engineer, to the *Russell*.

MILITARY ENGINEERING

RESIGNATION OF SIR WILLIAM ARMSTRONG.—Sir William Armstrong has sent in his resignation of the official position he has held for the last three or four years as ordnance engineer and superintendent of rifled ordnance construction in the War Department. The causes assigned for the step are, it is stated, wholly unconnected with the forthcoming experimental trials between the Armstrong and Whitworth guns, and Sir William only retires that he may attend more closely than his duties permitted him, to the extensive works of the Elswick Ordnance Company, in the success of which he has so large an interest. That company will, as hitherto, continue to manufacture rifled ordnance, both for the army and navy.

LAUNCHES OF STEAMERS.

LAUNCH OF AN AUSTRALIAN AND NEW ZEALAND MAIL STEAMER.—On the 7th ult., the *Paulet*, destined to convey the mails between Australia and New Zealand, was launched from the building yard of Messrs. Charles Mitchell and Co., at Low Walker, on the Tyne. She is an extremely handsome vessel. No expense has been spared in fitting her up for the extensive passenger trade between the two colonies; and among the modern improvements introduced into the cabin arrangements of this vessel is one that will be very acceptable aboard steamships in warm climates. A separate steam engine is to be erected on board this vessel for the purpose of thorougly ventilating the holds, cabin, engine-rooms; and so completely will the system be carried out, that each private cabin will be provided with a ventilating tube, so that each passenger will have the opportunity of regulating the draught to suit his individual convenience. The machinery to drive the *Paulet* is of 150 horse-power, and has been manufactured by Messrs. R. Morrison and Co., Newcastle. By the use of surface condensers, there will be a considerable economy in the consumption of fuel.

LAUNCH OF THE "LOTUS."—On the 21st ult., this fine screw steamer was launched from the building yard of Messrs. C. and W. Earle, Hull. She is intended for the Mediterranean trade, and is owned by Messrs. J. Moss and Co., Liverpool. The registered tonnage of the *Lotus* is 500 tons; her actual burden, however, will be about 800 tons, and her dimensions are—Length over all, 220ft.; breadth, 24ft.; and depth, 15ft. 2in.

TELEGRAPHIC ENGINEERING.

THE TELEGRAPH TO INDIA COMPANY.—The half-yearly general meeting of this company has been held. The directors in their report, after referring to previous transactions in connexion with the Persian Gulf line, and stating that the directors had found it necessary to discontinue for the present the station at Jubal, proceeded to state that they considered it the best course in the interests of the company to make arrangements with Messrs. Glass, Elliott, and Co., the lessees of the Malta and Alexandria cable, for working the Alexandria and Suez line for four years from 1st January, under which the line is to be worked and maintained in good condition, without any charge upon the company, by the lessees, who are to pay the company, so long as the Malta and Alexandria cable continues in working order, £2500 a year during the term of the lease. This will enable the board, unless any unforseen accident arises, to pay a dividend to the shareholders during the next four years of from 4 to 5 per cent. per annum. With regard to the Persian Gulf Telegraph the directors have applied for and obtained the sanction of his Highness the Viceroy of Egypt to construct a line to El Arish, with a view to completing the further communication to Beyrout, Iscanderoon, or Aleppo, and so connecting this company's line with Constantinople by one about to be constructed by the Ottoman Government from Diarbekir, on the direct line from Constantinople to India, and also by the Persian Gulf Telegraph with India. By this short and inexpensive addition the value of the company's property, in the opinion of the directors, will be materially increased, but they are advised that it would not be competent to the Company to make the line to Beyrout.

AN ELECTRIC TELEGRAPH ACROSS THE MERSEY.—In consequence of the frequent accidents to the submarine cable across the Mersey, through the fouling by ships' anchors, the cable has been taken up, and at present messengers perform the communications. It is, however, intended to erect on each side of the river two iron pillars, of about 240 feet in height, and on these to extend a strong steel wire, to which will be fastened the telegraph wires. The distance across the Mersey, where it is to proposed to erect these pillars, is about 1300 yards. In connection with the proposed alteration—which seems a very feasible one—we understand that there will be a submarine cable laid between the different lightships outside the port and the shore, which will be of immense service to the mercantile community, as it will accelerate the reporting of vessels off the port, and, in cases of storm, the position of vessels in distress, &c.

SUBMARINE TELEGRAPHY.—Although submarine telegraphy is an industry which only dates from 1851, it appears that the length of cable submerged to the present date is calculated at 15,176¾ miles. The following is a list of the principal cables laid by English firms up to 1857:—From Dover to Calais, 27 miles, laid in 1851 by Messrs. Wilkins and Wetherley, Messrs. Newall and Co., Messrs. Kuper and Co., and Mr. Crampton; from Holyhead to Howth, 73 miles, laid in 1852 by Messrs. R. S. Newall and Co.; from Denmark across the Belt, 18 miles, laid in 1853 by Messrs. R. S. Newall and Co.; from Dover to Ostend, 80½ miles, laid in 1853 by Messrs. R. S. Newall and Co. and Messrs. Kuper and Co.; across the Firth of Forth, five miles, laid in 1853 by Messrs. R. S. Newall and Co.; from Portpatrick to Donaghadee, 25 miles, laid in 1853 by Messrs. R. S. Newall and Co.; from England to Holland, four separate cables of 120 miles each, laid in 1853 by Messrs. R. S. Newall and Co.; from Portpatrick to Whitehead, 27 miles, laid in 1854 by Messrs. R. S. Newall and Co.; from Sweden to Denmark, 12 miles, laid in 1854 by Messrs. Glass, Elliott, and Co.; from Holyhead to Howth, 73 miles, laid in 1854 by Messrs. Newall and Co.; from Italy to Corsica, 110 miles, laid in 1854 by Messrs. Glass, Elliott, and Co.; from Corsica to Sardinia, 10 miles, laid in 1854 by Messrs. Glass, Elliott, and Co.; from Varna to Constantinople, 172 miles, laid in 1855 by Messrs. R. S. Newall and Co.; from Varna to Balaklava, 350 miles, laid in 1855 by Messrs. R. S. Newall and Co.; a cable, 10 miles

in length, laid off the Egyptian coast in 1855 by Messrs. Glass, Elliott, and Co.; from Italy to Sicily, five miles, laid in 1855 by Messrs. Glass, Elliott, and Co.; from Newfoundland to Cape Breton, 85 miles, laid in 1856 by Messrs. Glass, Elliott, and Co.; from Prince Edward's Island to New Brunswick, 12 miles, laid in 1856 by Messrs. Glass, Elliott, and Co.; in Norway across Fiords, 49 miles, laid in 1857 by Messrs. Glass, Elliott, and Co.; from Sardinia to Malta and from Malta to Corfu; 700 miles, laid in 1857 by Messrs. R. S. Newall and Co.; across the mouths of the Danube, three miles, laid in 1857 by Messrs. Glass, Elliott, and Co.; from Ceylon to the mainland of India, 30 miles, laid in 1857 by Messrs. Glass, Elliott, and Co.; from Sardinia to Bona, 125 miles, laid in 1857 by Messrs. R. S. Newall and Co. In 1858, 1859, 1860, 1861, and 1862, the submersion of telegraph cables proceeded in an accelerated ratio, only 2487 miles out of the 15,176½ miles indicated above having been thus far recapitulated.

TELEGRAPHS BILL.—The object of the bill brought before Parliament by the Board of Trade is to make general regulations in respect to all telegraph companies, existing and future, but not to affect existing companies in respect of a past exercise of powers. No telegraph, above ground, is to be placed within 10 yards of a dwelling home worth £20 a year, or across an avenue, or approach to such house, without the consent of the occupier of the house. But a subsequent provides that, where the body having the control of a street consents to a telegraph being placed along it, that consent is to be sufficient authority for placing the telegraph along or over any land or building "adjoining to, or near the street," but not directly over any building if the owner, or occupier, objects. Any person in the employment of a telegraph company wilfully or negligently delaying a message, or improperly divulging its purport, is to be liable to a penalty not exceeding £20. Every telegraph is to be open to all persons without favour, or precedence, except that messages on her Majesty's service are to have precedence if required by any department of the Government. Telegraphs also may be taken possession of for Her Majesty's service, if the Secretary of State is of opinion that an emergency has arisen in which it is expedient for the public service that the government should have control over the transmission of messages; the company to be compensated according to the average profits of the previous three months.

RAILWAYS.

SPANISH RAILWAYS.—The Madrid, Saragossa, and Alicante Railway Co., have opened another section of their wide network, which, when completed, will control over 700 miles. The section now made available lies between Murcia and Carthagena, and is 40 miles in length. The receipts of the system are steadily extending, and when the Saragossa division, which will open communication between France and Spain is completed, the earnings, it is calculated, will be at least £1,000,000, per annum.

A Barcelona paper announces that the construction of the railway of San Juan de las Abederas has been conceded to M. Bengoechea, the representative of a London house, who offered to take it for a term of ninety years without any subvention from the Government. There were eight tenders in all.

THE TOULON AND NICE RAILWAY.—It is announced that the section of this railway between Arc and Cagnes is ready for traffic, as a first experimental journey, made by a train carrying the engineers and principal officials, has been attended with perfect success.

DOUBLE-ACTING VENTILATOR FOR RAILWAY AND OTHER CARRIAGES.—An ingenious and simple apparatus for this purpose has been patented by Mr. M. Wigzell. It is intended to be inserted in a convenient position, such as above the glass slide in the door of the carriage, and may be briefly described as consisting of a double tube, put together in a ⊤ form, and inserted horizontally, so that the mouth of the inlet-tube will open forward on the route of the carriage, while the mouth of the outlet-tube opens in the opposite direction. There are, of course, interior openings, one for admitting the fresh air, and the other for egress of the foul.

THE MIDLAND RAILWAY.—This company are about to ask for Parliamentary powers to construct a line of 51¾ miles, giving them an independent entrance into London. The line is to extend from Bedford by way of Ampthill, Luton, and St. Albans, to London. Its estimated cost is £1,750,000. The Midland Company also propose to raise £1,140,000 this session for other purposes.

GREAT WESTERN CAPITAL EXPENDITURE.—The expenditure on capital account to the 31st of December, 1849, amounted to £10,917,378, including £1,016,592 for working stock; and from the latter date to the 31st December last, the expenditure on branch and extension lines, including £650,752 for new station at Paddington; £874,035 for additional rolling stock; and £817,684 expended on joint account, amounted to £11,247,371; and in addition to this, the aggregate sum of £2,208,567 had been subscribed towards twelve other undertakings, connected with Great Western railways, making the total expenditure on capital account by the Great Western Company £24,373,316, leaving a balance of £568,873.

LOCOMOTIVES.—It appears that the number of locomotives possessed by English railway companies at the close of 1861 was 4956. The Scotch companies had 848 and the Irish 352, making a total of 6156. At the close of 1860, the number possessed by the companies was only 5801, showing an increase in 1861 of 355. Having regard to the depreciation of existing stock, and the demand for engines for new lines, it is probably within the mark in estimating that 500 additional locomotives will be required in the British Isles alone for the next ten years.

RAILWAYS IN BAVARIA.—At the end of 1861 the entire length of railway opened in Bavaria was 703 English miles. The cost of construction has been on an average 224,570fl. per kilometre (⅝ of a mile). The rolling stock consisted of 228 locomotives, 590 carriages, and 4059 waggons and trucks for merchandise, &c. The carriages contained 20,747 places: 1159 first class, 5708 second, and 13,880 third. The locomotives cost 7,356,224fl., the carriages 1,326,184fl., and the waggons and trucks 7,074,966fl., making a total of 15,757,374fl., or 33,765,800f. The net profit of the working, deducting all expenses, amounted to 4,011,122fl., or 7292f. per kilometre.

RAILWAYS IN INDIA.—The length of railway now opened in British India is as follows:—On the Great Indian Peninsula system, 495 miles; on the East Indian, 750¼ miles; on the Madras, 418 miles; on the Bombay, Baroda, and Central India, 187½ miles; on the Scinde, 105 miles; on the Punjaub, 32 miles; on the Eastern of Bengal, 110 miles; on the Calcutta and South Eastern, 28½ miles; and on the Great Southern of India, 79 miles; making an aggregate of 2235½ miles.

FRENCH RAILWAY TRAFFIC.—The traffic receipts on the principal French lines were as follows:—On the Paris and Mediterranean for the year 1862 the traffic receipts amounted to 155,462.973f. (£6,218,513), against 144,473,601f. (£5,778,944) in 1861, showing an increase of 10,989,371f (£439,569). On the Eastern of France to 67,139,427f. (£2,685,577) in 1862, against 69,632,617f. £1,785,305) in 1861, showing a decrease of 2,493,190f (£99,728). On the Paris and Orleans to 75,624,900f. (£3,024,996) in 1862, against 75,683,428f. (£3,027,337) in 1861, showing a decrease of 58,528f. (£2341). On the Northern of France, 68,452.833f. (£2,738,113) in 1862, against 65,333,627f. (£2,613,345) in 1861, showing an increase of 3,119,204f. (£124,768). On the Western of France to 52,210,542f. (£2,088,422) in 1862, against 55,213,554f. (£2,208,542) in 1861, showing a decrease of 3,003,012f. (£120,120). On the Southern of France to 33,572,809f. (£1,342,912) in 1862, against 30,063,648f. (£1,202,546) in 1861, showing an increase of 3,509,161f. (£140,366). On the Lyons and Geneva to 6,914,641f. (£276,585) in 1862, against 7,026,795f. (£281,072) in 1861, showing a decrease of 112,154f. (£4,486). And on the Ardennes to 5,954,688f. (£238,188) in 1862, against 4,115,520f. (£164,621) in 1861, showing an increase of 1,839,168f. (£73,567). The aggregate receipts for the year 1862 on these lines, 10,641 kilometres in length (6614 miles), amounted to 465,332,813f. (£18,613,312), and for the year 1861, on 9630 kilometres (5985 miles), to 451,542,789f. (£18,061,712), with an increase of 629 miles and of 13,790,024f. (£551,601) in the receipts, of which increase, 13,002,835f. (£520,113) was on 2072 kilometres (1288 miles) of new lines of railway included above.

RAILWAY ACCIDENTS.

RAILWAY ACCIDENT ON THE BLACKWALL LINE.—A serious accident, unattended with loss of life, occurred on the Bow Extension of the Blackwall Railway, on the 9th ult. A heavy goods train was sent down from Camden-town to Haydon-square, and while passing over a viaduct not far from the Regent's-canal, a truck near the centre of the train got off the rails, and dragged all behind after it. The couplings held with more than usual tenacity, and the waggons became heaped up, one on another, in inextricable confusion. Before the engine-driver discovered the accident, and could bring the train to a standstill, the waggons had dashed against the parapet of the viaduct, knocking down a large part of the brickwork, and some portions of the train itself went over into the road below. There was a great destruction of property, and the traffic was stopped for the greater part of the day.

RAILWAY ACCIDENT AT PRESTON.—On the night of the 4th ult., an accident occurred on the Lancaster and Carlisle Railway Company's line at Preston. About eleven o'clock the train from Scotland and the North of England to London, &c., which was due at Preston at 10.40, but which had been delayed on the road, was proceeding along the line near Maudland Bridge, when a goods waggon, which had been placed in a coal siding, by some means broke loose and ran into the latter portion of the train, smashing four or five carriages and a van, and seriously injuring many of the passengers.

ACCIDENT AT THE CREWE STATION.—The passengers by the Irish "limited" mail train on the London and North-Western Railway had a very narrow escape on the 16th ult. The train, which is due at Crewe about 2·30 a.m., but does not stop there, dashed though the station at its usual speed, and had not proceeded very far beyond the bridge that crosses the line, when, from some cause, several of the carriages ra off the line and were much broken, and the passengers much shaken, but none were seriously injured.

DESTRUCTION OF THE KIDDERMINSTER RAILWAY STATION BY FIRE.—About half-past twelve o'clock on the night of the 14th ult., it was discovered that the Kidderminster railway station of the West Midland line, was on fire. Ass stance speedily arrived, but a sufficient supply of water could not be obtained for the engines, which, after some delay, made their appearance, and the station, telegraph office, and all Messrs. Smith and Sons' books, papers, newspapers, &c., were destroyed. After levelling the whole of the station to the ground, the flames next extended to the refreshment rooms (which, had the water been plentiful, might have been saved), and this shared the same fate as the rest. The telegraph wires were also destroyed.

ACCIDENTS TO MINES, MACHINERY, &c.

FATAL COLLIERY ACCIDENT AT LEEDS.—On the 9th ult. an accident of an alarming character took place at the Neville-hill Colliery, Leeds. For some time past, workmen have been engaged in deepening and repairing an old shaft, and at the time of the accident, two men were employed upon a "cradle," about seventeen yards from the bottom, when, without the slightest warning, the sides of the shaft collapsed, breaking down the scaffolding, and burying the two men beneath from eight to ten tons of *debris*.

COLLIERY EXPLOSION AT ABERDARE.—An explosion took place in the Navigation coal-pit at Mountain Ash, on the 7th ult. It would seem that there was no night shift, fortunately, and only a relay of men went down, after the day men ascended, to repair the pit. It was when they were at work that the explosion occurred. Two miners only met with their death, the remainder being soon rescued.

THE EAST COWES GASOMETER exploded at four o'clock on the afternoon of the 28th January last. The manager, Mr. G. S. Bellows, and a son of the steward of Parkhurst Prison, were killed. [We have since been informed that it was not the gasometer, but the station meter which exploded.]

GAS SUPPLY.

GAS DIVIDENDS.—The Worcester Gas Company have declared a dividend of 10 per cent. for the past half year. The Chester United Gaslight Company have also declared the same dividend; and have reduced their price so far as by granting 2½ per cent. discount on speedy payments. The Stoke, Fenton, and Longton Company have declared a dividend of 8 per cent., and state that an enlargement of their works has become necessary The Collingham Company have declared 6 per cent., besides a reserve. The Crowle Gas and Coke Company have declared a dividend of 10 per cent., leaving a balance in hand. The Alnwick Company have declared a dividend of 10 per cent., and resolved to reduce the price of gas 6*d*. per 1000 cubic feet, making it 5*s*. per 1000.

THE MANCHESTER GAS COMMITTEE have recommended the following reduced scale of charges in townships beyond the city on the near side of the Mersey, viz.:—When the quarterly consumption is under 500,000ft., 4*s*. 3*d*. per 1000ft.; 500,000ft. and under 1,000,000ft., 4*s*. 2*d*.; 1,000,000ft. and under 1,500,000ft., 4*s*. 1*d*.; 1,500,000ft. and upwards, 4*s*. In the district beyond the Mersey they recommend that the present price, 4*s*. 6*d*., should be continued.

SEWERAGE WORKS.

THE FLEET SEWER.—The extensive works in connection with carrying the Fleet sewer over the eastern curve of the Metropolitan Railway at King's-cross, which for some time has been in course of construction for the junction of the Metropolitan Railway with the Great Northern are completed. The water is carried through an iron channel, which is let into the top of the arch of the railway. The channel is 40ft. in length, 8ft. wide, and 9ft. high; and so important was the work considered, that the Metropolitan Board of Works sent Mr. Raeburn, clerk of works, to superintend its construction. Before the water was allowed to pass through, the channel was tested, both by Mr. Raeburn and Mr. Cordell, the manager for Mr. Jay, the contractor. The weight of the test was no less than 35 tons—a far heavier weight than the channel will ever be called upon to hear; but so substantial is the work, that the deflection was found to be only one-eighth of an inch.

CANALS.

IRRIGATION AND CANAL WORKS IN INDIA.—A contract has been executed by the Governor General of India and the above Company, for the construction of their scheme of works in Orissa, and the adjacent districts towards Calcutta. This is the first instance in which clauses of arbitration have formed part of the contract between the Government of India and a private company. The plans and estimates of a canal from the Hoogly to Balasore, 95 miles in length, are now complete, and its construction has been or is about to be immediately entered upon. The Government view this line from Calcutta to Balasore, as one of great importance, and express a strong wish for its completion as quickly as possible, so that there is every probability of the work progressing very rapidly.

BOILER EXPLOSIONS.

THE MANCHSTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.—A special meeting of the executive committee of this association was held on January 20th, 1863; in order to take into consideration a retrospect of the transactions of the association during the past year of 1862; when Mr L. E. Fletcher, chief engineer, presented his annual report relating to matters of an engineering character, from which the following facts are extracted:—"The defects discovered in boilers are mainly of two classes

one relating to their construction and the other to their condition. Under the first head, namely, that of construction, 196 recommendations had been made, which are as follows:—In 153 boilers the internal flue tubes have been recommended to be strengthened by hooping. In 18 boilers the shells have been recommended to be strengthened at the steam domes by stays of angle iron, &c. In 9 boilers the shells have been recommended to be strengthened at the ends. In 16 boilers the load on the safety valves have been recommended to be reduced. Under the second head, namely, that of condition, 85 defects have been discovered, all of which were considered dangerous, they are as follows:—Fracture of plates and angle irons, 13; blistered plates, 1; furnaces out of shape, 12; corrosion, 37; defective safety valves, 5; defective water gauges, 9; defective blow-out apparatus, 7; others not actually dangerous, but still unsatisfactory, were then given, which need not here be repeated. The report then went into a detailed consideration of the defects discovered under each of the above heads; some of the remarks on corrosion may be given. Corrosion is found to be going on in all boilers, more or less, and it will be seen that the greatest number of dangerous defects in the preceding table are to be found under this head. In one case a boiler set upon a mid-feather wall 15in. thick, had a channel eaten right along it about 8in. wide, which ran down the centre of the seating, while the plates at the edges of the brickwork appeared quite sound, and the danger consequently passed for some time unsuspected. In a second instance, with a mid-feather 2ft. wide, the plate was found to be eaten almost through from nearly one end of the boiler to the other—while in a third, where lime had been allowed to come in contact with the boiler at the mid-feather, the plate was completely pulverised and could be carried away in handfuls. In a fourth case, a vertical tubular boiler had been placed close to a wall, one part being in actual contact. Damp in the brick-work set up corrosive action in the plate, which being concealed by the position, went on undetected until the metal was completely eaten through, and a piece blown out by the pressure of the steam. The original plating of the boiler was thick, the pressure low, and the corrosive action local, only affecting a surface of about 12in. square, so that the rent did not extend. Examples of corrosion might be multiplied indefinitely; enough, however, has been said to show the importance of having all parts of the boiler accessible to examination, the flues sufficiently capacious, and the seatings as narrow as possible, and also of having the brickwork removed occasionally, at all events in places, so as to ascertain the condition of the plates, since to conclude that the parts concealed are in the same condition as those in view has been found in practice to be fallacious. Under the head of explosion it was stated:—It is to be regretted that no means exist of ascertaining the whole number of steam boiler boiler explosions that occur throughout the United Kingdom, and there can be no doubt that many are never recorded at all. There are known, however, to have occurred during the last year, no less than 31 explosions,, from which at least 87 persons have been killed, and 88 injured. Of the number of lives lost by some of the above, no account could be obtained; while from one of them, as many as 29 persons were killed and 12 injured; from a second, 12 were killed and 24 injured; and from a third, 6 were killed and 8 injured. The following list gives the description of boiler to which the explosions have occured, with the number of each class, as well as of the persons killed and injured:—4 haystack boilers—12 persons killed and five injured; 6 plain cylindrical egg-ended boilers—6 persons killed and 6 injured; 3 iron works boilers—47 persons killed and 44 others injured; 3 plain single-flued cornish boilers—2 persons killed and 2 others' injured; 2 plain double-flued Lancashire boilers—4 persons killed; 3 locomotive boilers—4 persons killed and 2 others injured; 1 agricultural boiler of tubular portable construction—4 persons killed and 4 others injured; 1 kitchen range boiler—1 person killed. Also 8 other boilers, of the construction of which no reliable information could be obtained, but from the explosion of which 27 persons were killed and 22 others injured. An analysis of the causes of explosion then followed, the summary of which only can be given:—Of 31 explosions which have happened during the year 1862, 11 occured to externally fired boilers, from failure of the plates exposed to the action of the fire; 3 resulted from internal corrosion, and 3 from external; in addition to which, 4 were due to improper original construction, one to shortness of water, and another to accumulated pressure through want of a safety valve; while 7 occurred at a distance which precluded a personal investigation of their causes, at the same time that no reliable information could be obtained with regard to them.

Cementation of Steel.—An invention has been patented by a gentleman in Paris, according to which he claims the application of wood divided into small parts, such as sawdust, the leaves of trees, and the envelopes of certain fruits for the cementation of the pieces of cast or forged iron to form steel suitable for the manufacture of cutlery, rails, tyres of wheels, and other articles.

MINES, METALLURGY, &c.

Lead Mines.—The number of lead mines worked in Cornwall in 1861 was 44; in Devonshire, 11; in Cumberland, 79; in Northumberland and Durham, 39; in Westmoreland, 6; in Cheshire, 1; in Shropshire, 9; in Yorkshire, 30; in Somersetshire, 4; and in Staffordshire, t; making a total for England of 224. As regards Wales, the county of Cardigan had 43 mines at work in 1861; Carmarthenshire, 3; Denbighshire, 14; Flintshire, 48; Montgomeryshire, 14; Merionethshire, 3; Pembrokeshire, 1; Radnorshire, 2; Carnarvonshire, t9; making a total of 147. The Isle of Man at the same time had 5 mines worked; Scotland, 7; and Ireland, 7; making a total for the United Kingdom of 390, as compared with 380 in 1860, and 264 in 1859. The quantity of ore raised does not show a corresponding increase. The metallic lead produced from this aggregate of ore was 65,634 tons in 1861, against 63,317 tons in 1860, and 63,233 tons in 1859.

Twelve Years of Pig Iron.—The computed make last year was, in round figures, 1,080,000 tons, as compared with 1,010,000 in 1861, 980,000 tons in t860, 960,000 tons in 1859, 940,000 tons in 1858, 910,000 in 1857, 820,000 in 1856, 822,000 tons in t825, 775,000 in 1854, 710,000 in 1853, 770,000 tons in 1852, and 775,000 tons in 1851. The production, last year, therefore, showed an increase of 305,000 tons or 30·35 per cent., as compared with 1851,—an astonishing advance in so brief a period. The total consumption scarcely kept pace with the production, having amounted to 978,000 tons last year, as compared with 935,000 tons in 1861, 917,000 in 1860, 910,000 tons in 1859, 833,000 in 1858, 840,000 tons in 1857, 830,000 tons in 1856, 842,000 tons in 1855, 885,000 tons in 1854, 935,000 tons in 1853, 680,000 tons in 1852, and 695,000 in 1851. The consumption last year, therefore, showed an increase of 283,000 tons, or 42·72 per cent. as compared with 185t, the deliveries last year having been in excess of any former 12 months, notwithstanding the general depression of trade. The stock, however, increased 102,000 tons last year; 75,000 tons in 1861, 73,000 tons in 1860; 50,000 tons in 1859, 147,000 tons in 1858, 70,000 tons in 1857, 90,000 tons in 1852, and 80,000 tons in 1851; in 1856 it decreased 10,000 tons; in 1855, 20,000; in 1854, 80,000; and in 1853, 225,000; but the general result was to increase the stock, December 31, 1862, to 637,000 tons, as compared with 350,000 tons, December 31, 1851. The shipments last year amounted to 571,000 tons, and the local consumption to 407,000 tons; in t861 the shipments were 585,000 tons, and the local consumption 350,000 tons; in 1860 the shipments were 567,000 tons, and the local consumption 350,000 tons; in 1859 the shipments were 587,000 tons, and the local consumption 343,000 tons; in 1858 the shipments were 558,000 tons, and the local consumption 275,000 tons; in 1857 the shipments were 528,000 tons, and the local consumption 312,000 tons; in 1856 the shipments were 505,000 tons, and the local consumption 325,000 tons; in 1855 the shipments were 542,000 tons, and the local consumption 300,000 tons; in 1854 the shipments were 542,000 tons, and the local consumption 300,000 tons; in 1853 the shipments were 635,000 tons, and the local consumption 300,000; in 1852 the shipments were 434,900 tons, and the local consumption 215,000; and in 1851 the shipments were 452,700 tons, and the local consumption 242,300 tons. The average number of furnaces in blast last year was 120, as compared with 123 in 1861, 121 in 1860, 124 in 1859, 129 in 1858, 128 in 1857, 117 in 1856, 117 in 1855, 116 in 1854, 111 in 1853, 110 in 1852, and 114 in 1851. The increase in the number of furnaces in blast was consequently only 5·26 per cent. last year, as compared with 1851, while the production increased in the same period as before indicated 39·35 per cent.; this discrepancy is to be attributed to the large increase in the results obtained from each furnace of late years. Notwithstanding the growth of the stock the average price realised last year was 53*s.* per ton as compared with 49*s.* 3*d.* per ton in 1861, 53*s.* 6*d.* per ton in 1860, 51*s.* 9*d.* per ton in 1859, 54*s.* 5*d.* per ton in 1858, 69*s.* 3*d.* per ton in 1857, 72*s.* 6*d.* per ton in 1856, 70*s.* 9*d.* per ton in 1855, 79*s.* 8*d.* per ton in 1854, 61*s.* 5*d.* per ton in 1853, 45*s.* 3*d.* per ton in 1852, and 40*s.* per ton in 1851. The increase experienced in the demand last year, and the consequent firmness in prices is attributed to the large demand for iron for shipbuilding purposes.

APPLIED CHEMISTRY.

Zinc Wash for Rooms.—Mix oxide of zinc with common size and apply it with a brush, like lime whitewash to the ceiling of a room. After this apply a wash in the same manner of the chloride of zinc, which will combine with the oxide and form a smooth cement with a shining surface.

The Presence of Arsenic in the So-called Pure Commercial Hydrochloric Acid, by M. Glenard.—So-called pure hydrochloric acid, sold by the manufacturers of chemical products, is often as arseniferous as the crude acids. Twice has M. Glénard, at a year's interval, examined numerous specimens of hydrochloric acid considered as pure. In two specimens very recently examined he found 2·5 grammes of arsenious acid per kilogramme. According to M. Gléuard, the presence of arsenic in hydrochloric acid may prove very injurious in the preparation of certain pharmaceutical products. It is, then, important that pharmaceutists should be aware of this fact, and abstain from employing hydrochloric acid which they have not previously tested carefully. The examination is attended, fortunately, with no difficulty. It is only necessary to mix the acid to be tested with its volume of a solution of hydrosulphuric acid, or to pass into it, during a few minutes, a current of this gas; or, better still, to throw into it a few morsels of artificial sulphide of iron. Under these three conditions, the acid, if it contains arsenic, will become troubled, owing to the separation of the yellow sulphide of arsenic. But how to obtain pure hydrochloric acid? M. Glénard proposes:—1st. The direct preparation of this acid; 2nd. The purification of commercial acid. In the direct preparation, the first step is to ascertain that the sulphuric acid is free from arsenic; otherwise, the arsenic, transformed during the preparation of the hydrochloric acid into very volatile chloride of arsenic, will escape with the acid, and with it become condensed in the water. The first thing to do is to eliminate the arsenic from the sulphuric acid. To effect this, the acid is diluted with half its weight of water, and to it is added a little hydrochloric acid, and then a current of hydrosulphuric acid gas is passed into it. The arsenic soon separates in the form of sulphide. It is next filtered through a funnel packed with amianthus, then heated in a capsule, to expel the excess of sulphurretted hydrogen, and to bring it to 60° of Baumé's areometer. The sulphuric acid thus purified is employed in the ordinary way, and furnishes perfectly pure hydrochloric acid. After describing the simple and ingenious process which consists in disengaging, by means of concentrated sulphuric acid, the hydrochloric gas contained in commercial acid, and in condensing this gas in distilled water, M. Glénard proposes the following method:—Into the crude acid to be purified a current of hydrosulphuric acid is passed until all the arsenic is precipitated. The sulphide of arsenic is separated either by letting the acid stand or by filtering it through a funnel packed with amianthus. Should the filtered liquid contain excess of sulphuretted hydrogen, some grammes of a concentrated solution of perchloride of iron are added, which destroys the hydrosulphuric acid, becoming reduced to protochloride. As the hydrochloric acid would then contain only fixed matters, it could then be rectified. Hydrochloric acid gas is displaced by means of sulphuric acid freed from arsenic.

Process for Extracting Soda from Cryolite.—Take eight tons of cryolite to eleven tons of chalk or calcareous stone, and pulverise separately, as fine as possible, by vertical mill-stones, and sift, still separately, through movable tammies; then mix, and re-grind by vertical mill-stones. (The portions of cryolite and chalk remaining in the tammies are again ground and sifted separately, then mixed and re-ground as in the first operation.) The mealy powder produced in this way is placed in furnaces constructed for the purpose, wherein it is baked and constantly stirred with iron instruments. During baking, the material must be carefully watched, to prevent it from fusing. When at white heat, it is taken from the furnace, and, when sufficiently cooled, to be sifted through an iron sifter; the lumps which may have agglutinated during the baking are separated. (After eight days, when, from the influence of the air, these morsels have lost some of their coherence, they are ground before being re-baked.) The calcined product is sifted and put into washing-tubs, and boiling water poured upon it, until no more soda remains to be extracted. The lixivium is conveyed into reservoirs intended to receive the carbonic acid destined for the saturation. The carbonated lixivium is directed into receivers, at the bottom of which clay is deposited. After clarification, the supernatant liquid is pumped, either into evaporating pans, to be reduced to the point necessary for crystallisation, or into calcining vessels, if salt of soda is to be produced. Carbonic acid is obtained from the furnaces used to calcine the mixture, whence it is conducted by canals into a purifying apparatus, and thence into its reservoirs (iron cylinders; the boilers of a steam-vessel will answer the purpose.) This operation, during which three tons of coal are burnt, produces t75 kilog. of crystals of soda, and 16 kilog. of pure alumina per 100 kilog. of cryolite. Theoretically, the 100 kilog. of cryolite ought to yield 204 kilog. of crystals of soda, and 24 kilog. of alumina. The alumina is used in manufacturing alum, sulphate of alumina, aluminate of soda, or aluminium.

Method of Decomposing Rock Salt.—Sea salt in the state of rock salt, and sulphate of lime in the state of anhydrite, gypsum, or plaster stone, are always found in proximity in the mineral kingdom, particularly in variegated marls. Of this we have a striking example in the lower strata of the department of the Meurthe. Sulphuric acid, lime, chlorine, and sodium, when associated, are arranged so as to form on one side sulphate of lime, and on the other chloride of sodium. It will be admitted that it is under these forms that the above substances manifest the greatest degree of stability, and not as sulphate of soda and chloride of calcium. An inverse arrangement has been in vain attempted. *A priori*, the thing is not feasible when the operation is confined exclusively to these substances. A different result altogether is obtained by calcining the mixture of these two salts, after adding to them a certain amount of peroxide of manganese. In this case sulphate of soda is always produced. In this operation the theory which guided M. Nicklés is exceedingly simple: he counted on the possibility of displacing the chlorine of chloride of sodium by the oxygen of a peroxide; for instance, peroxide of manganese, to obtain the soda necessary for the production of sulphate of soda. This, in fact, takes place; the displaced chlorine is disengaged, the crucible retains sulphate of soda, lime, and any excess of the manganese and sulphate of lime employed. The maximum of sulphate of soda which M. Nicklés has been able to obtain, under these conditions, is 15 per cent. It would, no doubt, be difficult to exceed this quantity, on account of the volatilisation of the chloride of sodium,—volatilisation which takes place just about the temperature at which the above decomposition is effected.

Carbonic Acid as an Anæsthetic.—M. Ozanam has given a mixture of three parts carbonic acid with one part atmospheric air with success as an anæsthetic. After breathing it for ten minutes the patient became insensible, and an operation was performed without his evincing any sign of pain.

LIST OF APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF "THE ARTIZAN."

DATED JANUARY 27th, 1863.

232 H. H. Henson—Fabrics.
233 G. Davies—Preserving provisions.
234 W. Gilpin & J. Hiatt—Fastenings of umbrellas and parasols.
235 C. F. Ash—Cornices, joints, and laths of bedsteads.
236 C. Askew—Railway chair and joint for rails on railways.
237 W. Rollason—Metallic boxes
238 R. A. W. Green—Light rowing boats.
239 J. Edmondson & T. Ingram—Looms and apparatus for weaving.
240 T. Gordon — Damping and affixing postage stamps to letters.
241 D. E. Hughes—Apparatus for effecting telegraphic communications.
242 W. C. Wilkins—Lamps.

DATED JANUARY 28th, 1863.

243 H. B. Barlow—Preserving timber.
244 H. Watson—Heating arrangements of stoves for drying woven fabrics.
245 T. Parkinson—Carding engines
246 W. E. Gedge—Fastening by screws boots, shoes, and other articles composed of leather.
247 E. F. Prentiss & J. C. Sellars—Treating rock oil, petroleum, paraffine oil, coal oil, and paraffine and other mineral oils and products therefrom.
248 J. Oglesby, J. Dickinson, W. M. Dickinson, & J. Dickinson—Steaming, cooking, and generating gas.
249 H. O. Cook & E. G. Terrey—Propelling ships and vessels.
250 C. Mace—Steam engines for propelling vessels.
251 R. Ward—Locking-up or fastening forms of type or other printing surfaces.
252 F. W. Wymer—Steam engines.
253 J. Platt—Rotatory engine.
254 W. Comsbee—Cylindrical chromo-lithographic printing machines.
255 S. W. Francis—Revolving shutters
256 W. Clark—Copying and reproducing sculpture and other objects of art
257 J. H. Johnson—Braid.
258 C. P. Stewart & J. Robinson—Giffard's injector, and the adaptation of it to locomotive and other boilers.
259 E. G. Muntz—Securing axles and axle boxes.
260 H. Crichley—Reaping and mowing machines.
261 B. J'Anson Bromwich—Obtaining and applying motive power.

DATED JANUARY 29th, 1863.

262 H. A. Bonneville—Construction of granaries.
263 T. A. Weston—Coupling and break for transmitting, regulating, or arresting motion.
264 J. B. E. Louit—Glass chimneys.
265 J. Mackenzie—Shaping machines for curvilinear surfaces.
266 R. A. Brooman—Candles.
267 J. Pouncy—Obtaining, transferring, and printing from photographic pictures or images.
268 W. Ball & J. Wilkins—Looped fabrics.
269 J. Nadal—Fountains.
270 N. Clayton & J. Shuttleworth — Thrashing machines.
271 C. H. G. Williams—Red colouring matter.
272 A. Pritchard — Preserving the contents of packages from air, water, or damp.
273 G. Blake—Apparatus for heating and warming.
274 W. Clark—Condensation of steam.
275 J. Sainty—Feeding troughs for sheep and other cattle.
276 F. G. Stuber—Air-tight boxes, cases, cupboards, and similar vessels.

DATED JANUARY 30th, 1863.

277 J. W. Branford—Longitudinal and transverse hoe.
278 W. E. Gedge—Cleansing chimnies and other flues.
279 W. E. Gedge— Cones for moulding refined sugar.
280 J. Cocker—Turnstile.
281 N. P. C. Lloyd—Engines.
282 W. E. Newton—Couplings for railway carriages.
283 W. E. Gedge—Hair nets.

DATED JANUARY 31st, 1863.

284 M. Smith—Looms for weaving.
285 J. Lightfoot & F. Trachsel—Distillation of certain substances.
286 T. Bennett—Obtaining pictorial back-grounds, fore-grounds, and perspectives when taking photographic portraits or sun pictures.
287 J. Grossmith—Producing the aura electric gas.
288 F. Tolhausen—Cleaning the beams of mules and spinning frames, collecting the dust and waste thereof, and also for cleaning the flooring underneath the mule carriages.
289 W. Drummond—Stopping the supply of gas to burners when the light is put out.
290 W. A. Lyttle—Cigar and tobacco smoking appliances.
291 E. B. Wilson—Supplying air, gases, steam, or fluids to iron and other furnaces, and to engines and vessels.

DATED FEBRUARY 2nd, 1863.

292 F. G. Grice—Bolts, spikes, rivets, and screw blanks.
293 E. H. Massey—Compositions for coating and colouring the walls, ceilings, and other parts of buildings.
294 J. Gibson—Looms for weaving.
295 A. Forbes—Soldering together parts of vessels formed of tin or tinned plate.
296 W. C. Barnes—Shaping, rolling, or compressing metal.
297 R. H. Frith—Paper.
298 E. B. Wilson—Gas.
299 W. Clark—Armour plated and other ships.

DATED FEBRUARY 3rd, 1863.

300 C. & G. L. Smithies—Preparing and bleaching Rhea.
301 T. Raworth—Looms for weaving.
302 G. Holeroft—Preparing cotton for spinning and weaving.
303 S. Oddy & E. Oldfield—Carding engines.
304 J. Fletcher—Injector for feeding boilers with water.
305 A. T. Blakely & J. Vavasseur—Projectiles for ordnance.
306 T. L. Jacobs—Cleaning casks.
307 W. G. Valentin & F. Levick—Generating combustible gases.
308 W. E. Newton—Reflectors.

DATED FEBRUARY 4th, 1863.

309 G. Hurton—Wood paving.
310 J. Mellor—Distilling, subliming, and drying.
311 T. E. Tallent—Leather.
312 T Bradford—Washing, wringing, and mangling clothes.
313 G. Haseltine—Uniting metallic surfaces.
314 G. T Bousfield—Postage, revenue, and other stamps, and apparatus for post marking and cancelling postage and other stamps.
315 J. J. Hays—Hot-air stove for purifying or filtering the gaseous products of combustion.
316 L. J. H. Marville—Covering for the ears.
317 Z. M. Parkes—Iron and other metal bond for use in building.
318 W. T. Weston, Spring Catch for windows, etc.
319 B. Russ—Iron ships or vessels.
320 C. & D. Faulkner, J. Fairley & W. C. Stiff—Gun barrels.
321 J. A. Manning—Treatment of night soil.
322 W. Stokes—Window sashes.

DATED FEBRUARY 5th, 1863.

323 W. T. Mabley & W. T. Cheetham—Blowing organs.
324 J. Gill & J. Parkin—Polishing yarn, twine, and threads.
325 W. Betts — Applying metallic capsules to bottles.
326 H. Dircks & J. H. Pepper—Apparatus for the exhibition of dramatic and other performances.
327 E. Ingham—Dyeing wool in the sliver.
328 R. A. Brooman—Supplying and spreading wool and other filamentous materials on belts, tables, and other surfaces, to be afterwards carded and otherwise acted on.
329 J. Paterson—Buckle and book fastenings.
330 R. A. Brooman—Tuning pianofortes.

DATED FEBRUARY 6th, 1863.

331 B. F. Bates—Cannon and projectiles to be used therewith.
332 A. Heintzmann & T. A. Rocbussen—Boring bench for gun barrels.
333 T. Blakeley & B. Meakes—Lead and stone pencil sharpener.
334 A. Johnston—Propulsion of vessels.
335 G. Stevens—Effecting a regular supply of air or aeriform fluids for various purposes.
336 A. Clarke—A. Clarke—Knife-cleaning.
337 R. A. Brooman—Carding engines.
338 W. Robins—Fire lighters.
339 J. Price—Signal lanterns.
340 R. D. Tivnann—Holster boxes.
341 A. Ellissen—Treating sheeting and iron plates.

DATED FEBRUARY 7th, 1863.

342 J. Cameron—Iron and alloys of iron.
343 J. Siron—Medicinal preparation for internal and external application.
344 J. Mallison—Dyeing yarns.
345 G. Turner—Mincing meat.
346 W. T. Cooper—Distilling apparatus.
347 C. Parigot & A. Grivel—Eccentric locks.
348 W. Clark—Application of gas for the preparation of wood work generally and iron ships for their better preservation and reception of paint or other protecting coating, and for disinfecting ships, hospitals, and other places.
349 J. James—Covering for hooped skirts.
350 J. Miller & W. Struthers—Securing the corks, stoppers, or lids of jars and bottles.
351 M. Hackforth—Shades or reflectors.
352 G. Redrup—Cutting chives, bungs, corks, spiles, and vent or other pegs.
353 D. Groucutt—Iron for making nails.

DATED FEBRUARY 9th, 1863.

354 B. Dobson & E. Barlow—Carding engines.
355 H. G. Williams & R. Price—Crushing and amalgamating auriferous quartz, and pulverizing and washing ores.
356 J. Mcintosh—Obtaining and applying motive power.
357 D. Law & J. Downie—Traction engines or common road locomotives.
358 J. Goucher—Regulating the admission of air into the furnaces of steam boilers.
359 H. & J. Smith—Depositing seed and manure.
360 W. B. Rooff—Respirator.

DATED FEBRUARY 10th, 1863.

361 J. Crosby & J. B. Smith—Carding engines.
362 T. Hill—Protection of markers at rifle butts.
363 R. Burley—Handles for hammers, mallets, picks, and mattocks.
364 M. Wigzell—Candles, tapers, and other lights.
365 M. Cartwright—Combining plastic substances with metals.
366 J. F. Bottom—Dressing lace.
367 W. Whitaker & W. Tongue—Steeping, boiling, washing, bleaching, and dyeing fibrous materials or slivers, slubbings, rovings, yarns, or woven fabrics of the same.

DATED FEBRUARY 11th, 1863.

368 A. Corneau—Hot-air stove.
369 H. Donald—Shearing, punching, and riveting metals.
370 E T. Hughes—Drilling wood, stone, iron, or other materials.
371 J. Duckworth—Paper.
372 D. Radcliffe—Valve taps.
373 C. P. Carter—Road making.
374 R. Saunders—Pavements and floors.
375 W. Symington—Weaving.
376 R. A. Brooman—Photographic apparatus.
377 E. Humphrys—Steering ships.
378 H. Wycherley—Applying wings or dirt screens

DATED FEBRUARY 12th, 1863.

379 F. Oppenheim—Plastic compounds for dental purposes.
380 E. Kemp, J. Needham, & O. Robinson—Self-acting mules for spinning.
381 A. Morton—Lawn mowing machines.
382 W. Clark—Bearing surfaces of shafts and other axles.
383 S. H. Phillips—Fastening for purposes, portemonnaies, pocket books, bags, reticules, and such like purposes.
384 S. Lumb—Machinery for tenoning, grooving, sawing, and otherwise cutting wood.

DATED FEBRUARY 13th, 1863.

385 G. H. Birkbeck—Extracting silver or other metals from lead.
386 S. M. Innes—Pianofortes
387 W. E. Gedge—Table apparatus for promoting the comfort of persons at sea.
388 J. Joues—Lead, tin, and other metals.
389 J. F. Spencer—Steam engines.
390 J. Robertson — Printing woven fabrics by blocks.
391 J. Grantham—Hydraulic presses.
392 W. Robertson—Machines for spinning and doubling.
393 G. Wrigley & S. Morris—Machines for spinning and doubling.
394 O. H. Hodge—Hat brims.
395 J. A. Schlumberger—Heating coal tar dead oils, and for producing pheuic or carbolic acid.
396 S. Whitaker—Indicating the positions or conditions of railway signals and points.

DATED FEBRUARY 14th, 1863.

397 G. Haseltine—Lever horse powers.
398 R. Bagoley—Creels for warping machines.
399 J. C. Jeffcott—Production and generation of gases.
400 W. C. Paul & A. T. Shore—Spring mattresses and other articles for sitting and reclining upon.
401 J. S. Gisborne & W. Simpson—Rendering ships and other compasses insensible to local attraction.
402 H. Dembinski—Motive apparatus and processes for giving to it a continuous motion and unlimited strength.
403 W. Baylis & T. H. Hopwood—Tongs.
404 W. Wood—Cutting screws or threads.
405 J. Lewis—Driving sewing machines.
406 J. H. Walsh—Breech-loading fire arms and cartridge cases.
407 T. Thorne—Disengaging ships' boats.
408 W. Clark—Separating the fibres of straw, wood, and other vegetable substances, and extracting the gummy and colouring matters therefrom.
409 A. J. Fraser—Window furniture.
410 J. & H. Higgins—Carding engines.
411 F. E. Walker—Breech-loading fire-arms.
412 J Morgan—Embalming and preserving from decay human bodies and bodies of other animals, also pickling, curing, and flavouring animal bodies.
413 J. H. Johnson—Wrought iron casements.

DATED FEBRUARY 16th, 1863.

414 M. Ohren—Self-acting gas holders.
415 J. W. Crossley—Drying press papers.
416 C. D. Abel—Omnibus.
417 W. C. McEntee & G. and T. Withers—Locks.
418 J. B. Watts—Matchets and swords.
419 H. Smith—Feeding horses.
420 R. A. Brooman—Protection for steel and other metal springs, ribbands, and hoops.
421 W. Jackson—Pumps.
422 J. H. Haywood & W. Vernon—Packing bonnet fronts, and rouches.
423 S. W. Clough—Signalling on railways.
424 W. Nalder—Rotatory screens.
425 T. Wilkinson—Singeing pigs.

DATED FEBRUARY 17th, 1863.

426 T. W. Salmon—Washing machines.
427 J. Lee—Ploughs and harrows.
428 W. T. Dibb—Brewing.
429 W. C. Ford—Paddle-wheels.
430 J. Gunson—Punching or cutting out leather and other substances.
431 E. Deville—Floating or life preserving coat or garments.
432 J. Durant—Chimney tops.
433 G. Home—Projectiles.
434 J. W. Lane—Fastenings for studs, sleeve fasteners, solitaires, bracelets, brooches, and other uses.
435 S. Pluchart—Food for horses.
436 H. Tomlinson—Stoves or fire-places for warming apartments.
437 D. Tassin—Preventing the explosion of steam boilers.
438 E. Strawson—Finishing with greater facility articles of dress manufactured either by hand or sewing machines.

DATED FEBRUARY 18th, 1863.

439 G. K. Geyelin—Perfect combustion of the various components of coal in open fire-places.
440 M. Siegrist—Atmospheric brake.
441 J. Barker and F. Moss—Portable and stationary crabs or cranes.
442 J. F. Spencer—Regulating and working the valves of steam and other engines.
443 J. H. Bly—Cooking stoves.
444 F. Johnston and R. Heatley — Looms for weaving.
445 J. Platt and W. Richardson—Cleaning cotton from seeds.
446 G. T. Bousfield—Breech-loading fire arms.
447 F. J. Reed—Traversing guns.
448 G. T. Bousfield—Boots and shoes, and preparing india-rubber for such and other uses.
449 J. Puntis and G. Cox—Appliances for displaying in the open air or indoors illuminated designs, devices, mottoes, or announcements, and in which jets of gas are employed as the illuminating agent.
450 J. Gray and J. Hudson—Treatment of steatite, and its application to certain purposes.

DATED FEBRUARY 19th, 1863.

451 R. P. Roberts—Axle boxes for carriages or vehicles.
452 T. Markland and J. C. Dickinson—Warping or beaming yarns or threads.
453 W. Sherwood—Wine glasses.
454 L. A. Pouget—Oil lamps
455 R Pinkney—Metallic pens.
456 J. J. Badart—Preparation of cotton seed cake.
457 W. Trustrum—Oiled silk.
458 N. Thompson—Shaping bottles, jars, and other vessels.

DATED FEBRUARY 20th, 1863.

459 H. B. Barlow—Weaving.
460 W. Marsden—Envelopes.
461 W. Marsden—Buttons.
462 C. Billingsley—Saddlery, harness, and driving straps.
463 J. Bentley and H. Booth—Looms for weaving.
464 C. W. Siemens—Insulating and supporting telegraph line wires.
465 W. Hainsworth—Cast iron pipes, columns, or any description of tubing.
466 R. Bell—Armour plating for protecting ships and vessels.
467 W. Clark—Boilers for disintegrating and pulping vegetable substances.
468 W. Clark—Projectiles for ordnance.
469 F. W. Bennoorf—Governors for regulating steam engines.
470 W. Husband and J. Quick—Raising sewage and water.

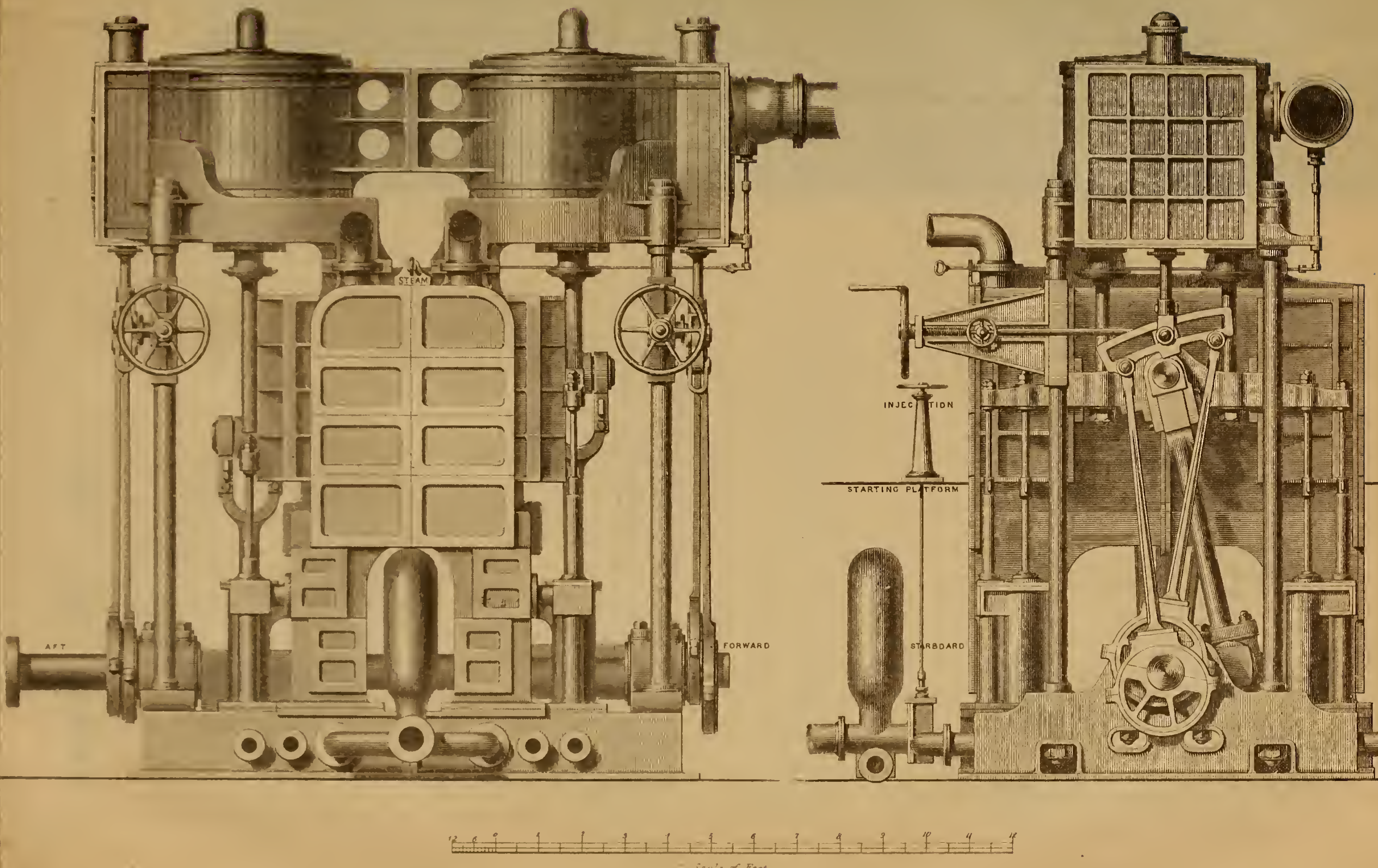
DATED FEBRUARY 21st, 1863.

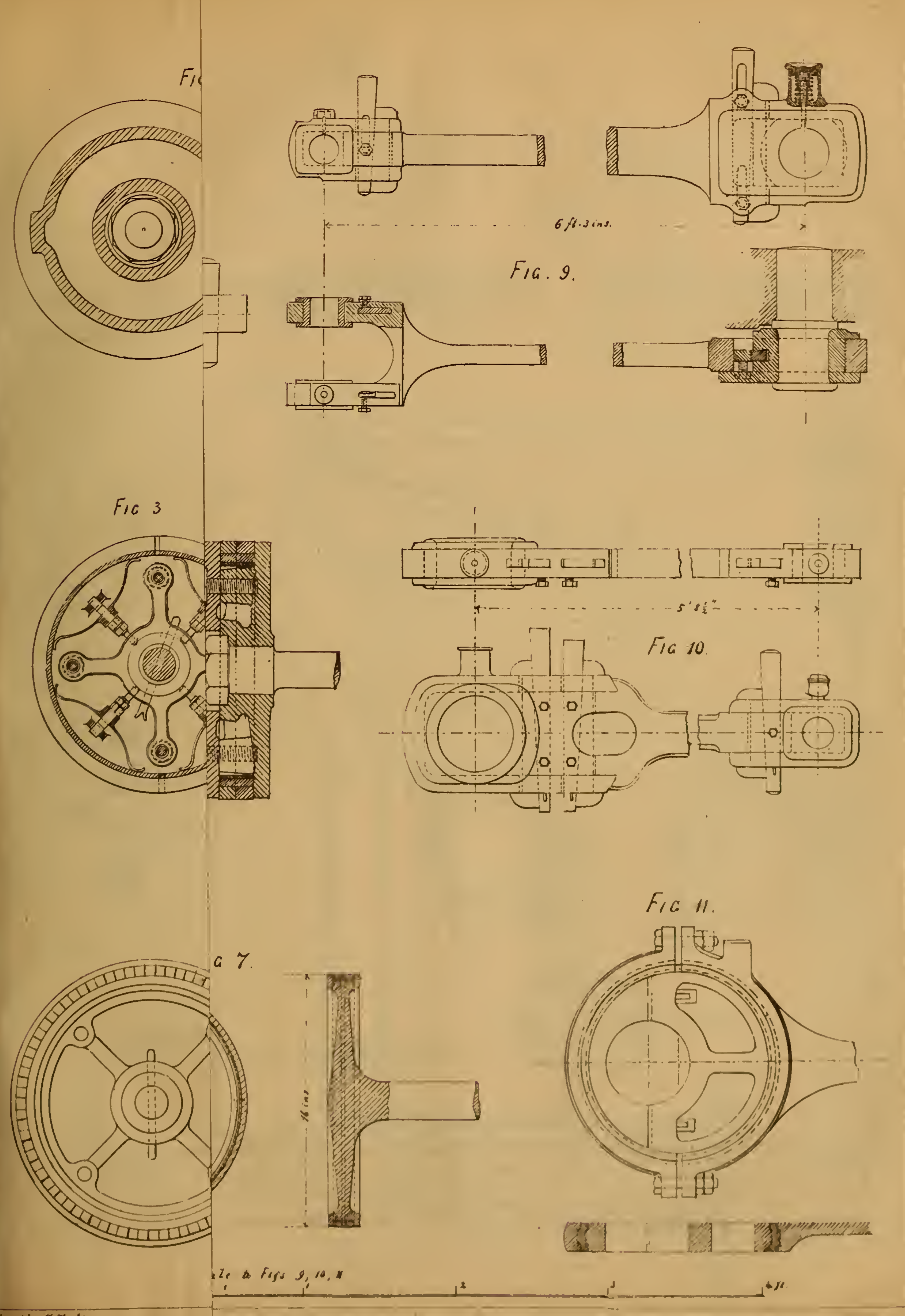
471 C. Malpas—Kilns for firing, burning, or baking pottery, bricks, tiles, and other earthen or ceramic articles.
472 R. Thompson—Moulding.
473 H. Kilshaw and T. Elce—Preparing and doubling cotton.
474 F. J. Manceaux—Fire-arms.
475 E. T. Hughes—Treatment of colouring matters derived from tar for the purpose of making them applicable for painting.
476 R. V. Dodwell—Preventing the destruction of plants by insects.
477 A. H. Remond—Preserving provisions.
478 A. Ceileur—Taking photographic impressions or likenesses by means of the camera.
479 W. Wood—Pomfret or liquorice cakes, rolls, sticks, and pipes.
480 H. Mackinder—Separating potatoes into different sizes.
481 J. Brown—Armour plates for ships.
482 A. Dugdale—Throttle valves.
483 W. E. Newton—Wind instruments of music.
484 N Wiard—Ordnance and artillery.
485 W. H. Gauntlett—Heating the blast in the manufacture of iron.
486 E. T. Hughes—Cleaning organic matter.
487 J. Eckersley—Spinning and doubling silk.
488 R. A. Brooman—Dressing millstones, ornamenting or engraving on glass, pottery, and other similar substances.
489 J. P. F. Datichy—Steam engines.
490 J. D. and A. P. Welch—Blocking and pressing hats and bonnets.
491 R. Marindale—Lamps and burners.
492 T. R. Harding—Carding and combing flax, wool, and cotton.
493 T. and A. L. Dickens and H. Heywood—Ornamenting plush.
494 J. Tatham—Preparing cotton and other fibrous materials for spinning.
495 J. Erwood—Producing imitation gilding in paper hangings.

J. F. SPENCER'S PATENT SURFACE CONDENSING SCREW ENGINES OF 200 H.P.

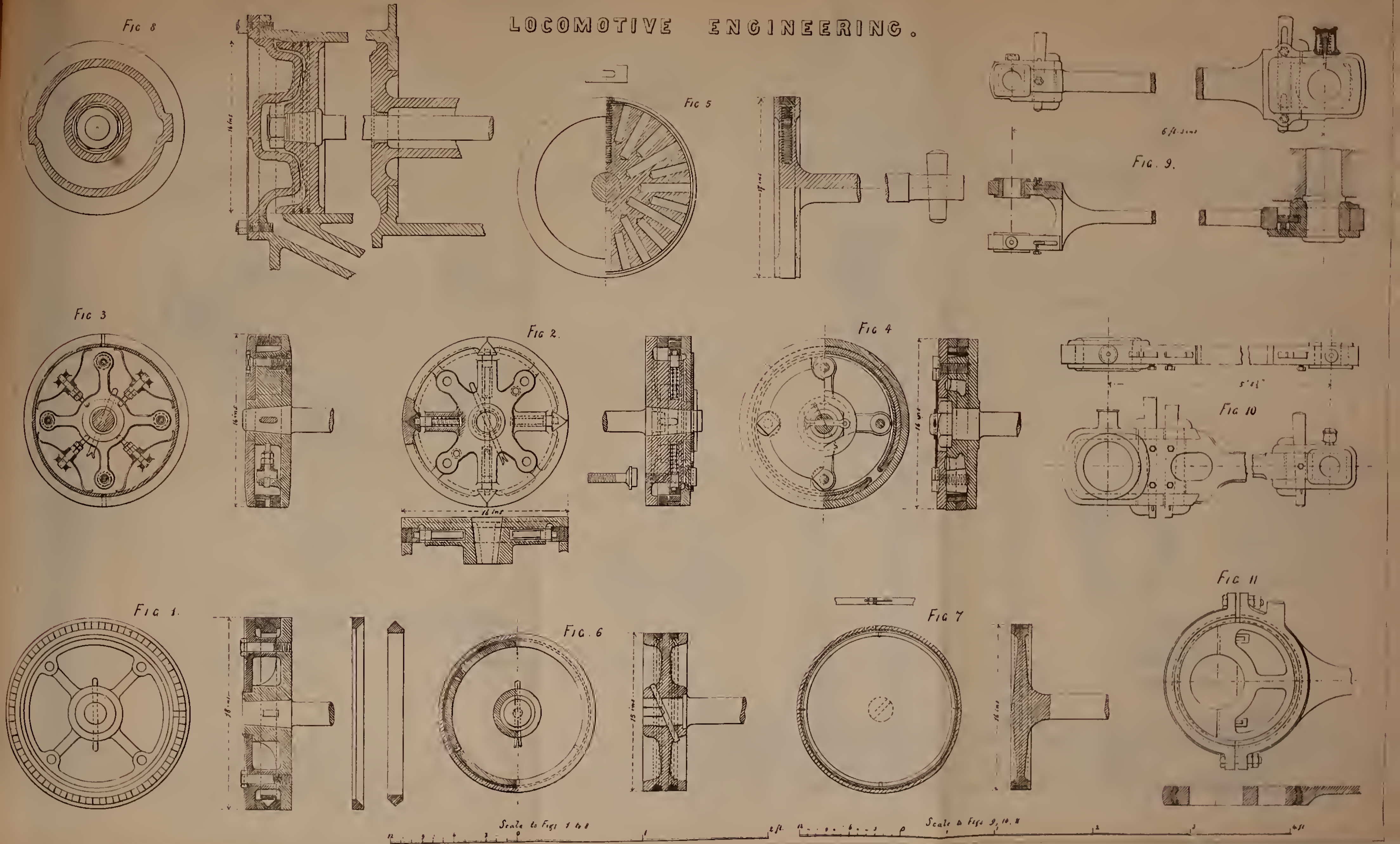
FOR A 1500 TON STEAM SHIP

BY MESSRS DENNY & Co ENGINEERS. DUMBARTON.




Fi
6 ft. 3 ins.
Fig. 9.
Fig 3
5' 8½"
Fig 10.
Fig 11.
g 7.
16 ins
ale to Figs 9, 10, 11
1
2
3
4 ft.

LOCOMOTIVE ENGINEERING.



mith, C.E. direx

MOTIVE ENGINEERING.

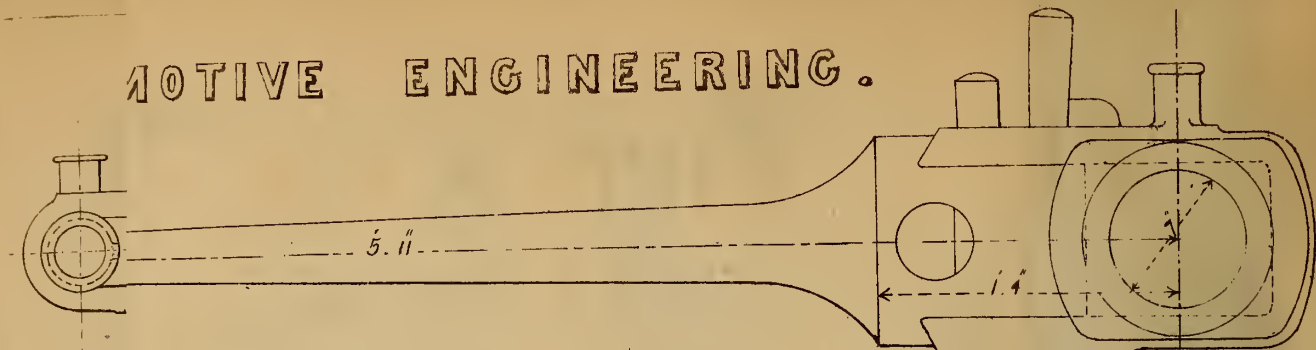
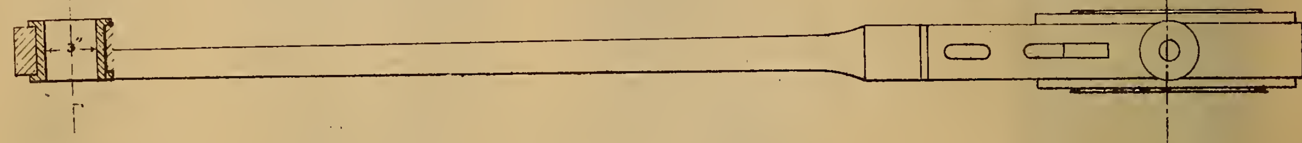


FIG. 2.



. 5.

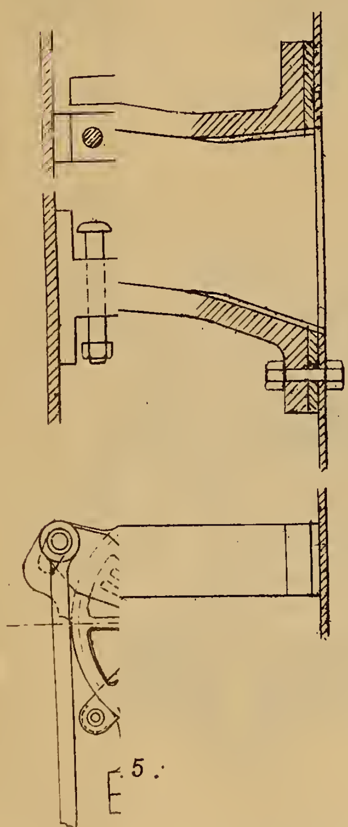


FIG. 8.

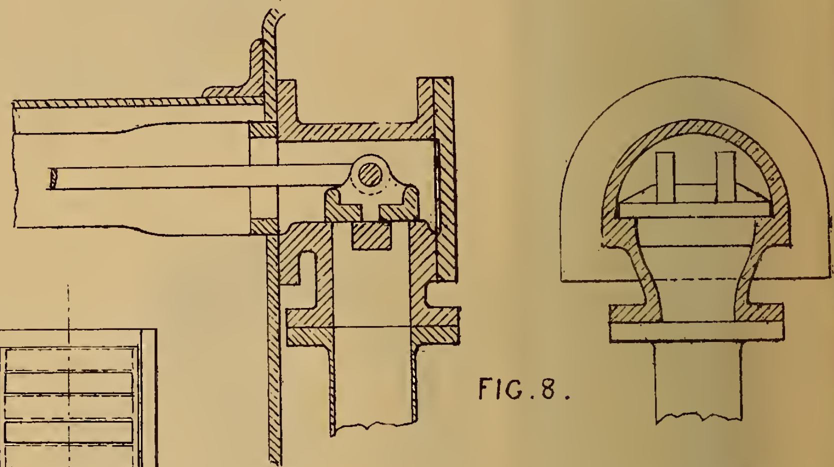


FIG. 9.

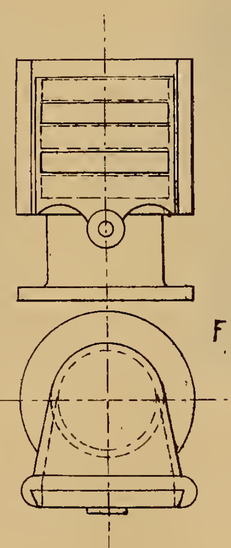


FIG. 12.

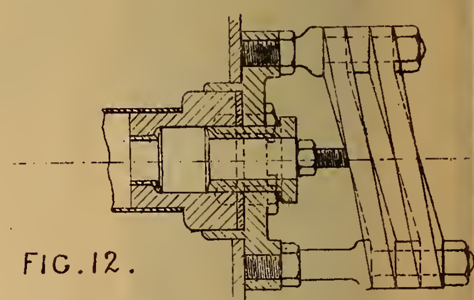
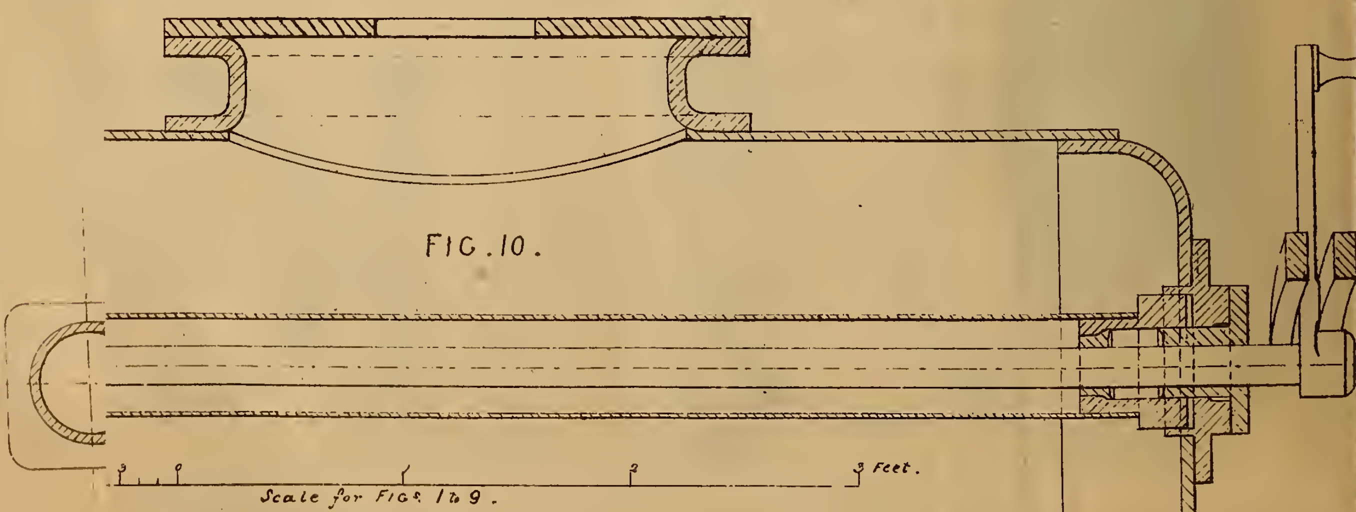


FIG. 10.



Scale for Figs 1 to 9.

W. Smith.

THE ARTIZAN.

No. 4.—Vol. 1.—Third Series.

APRIL 1st, 1863.

A CRITICAL AND HISTORICAL REVIEW OF LOCOMOTIVE ENGINEERING.

By J. J. Birckel.

(*Illustrated by Plates* 238 *and* 239.)

(*Continued from page* 56.)

We should here observe that Dr. Rankine, in his work on "Prime Movers," also shows that the motion of the valve, as derived from the link, may always be referred to a single eccentric; and the method which he gives for defining the throw and position of that eccentric for any point of the link is very nearly identical with that given in the last number of the Artizan. There is, however, this difference, viz., that the rule given in the work on "Prime Movers" does not provide for the obliquity of the eccentric rods.

Having thus completed our study of the steam distributing apparatus, we now proceed to treat of the remaining questions appertaining to the steam engine proper, the first of which being those which relate to the apparatus for the transmission of power, namely, the piston, the piston rod, the connecting rod, the crosshead, and the slide bars: and, in order to render our review as complete as possible, we will cast a rapid glance at the construction and the proportions of each of these parts.

The duty imposed upon the piston is to retain the steam in its front, while the latter, by virtue of its expansive force, causes the former to perform its alternate backward and forward motion. Any leakage occurring between the body of the cylinder and the packing of the piston gives rise to a twofold loss; it is a *direct* loss of power through waste of so much steam from which no duty is obtained, and it is an *indirect* loss of power through increase of back pressure. At the same time, a piston packing may be made so tight as to absorb the greater part of the power of the engine by friction, and here, therefore, is a problem essentially experimental in its nature, the satisfactory solution of which is of the highest importance. Piston packings may generally be divided into three kinds, namely:—

1st. Those which are made tight by means of springs.

2nd. Those which are intended to be made tight by the pressure of the steam itself.

3rd. Those which are tight by virtue of their own elasticity.

Pistons and packings of the first kind are illustrated by Figs. 1 to 5 (Plate 238), among which Fig. 1 is Goodfellow's patent, we believe one of the oldest in use; its construction is very simple, and, being made wholly of cast iron, it is very cheap; Fig. 2 is Critchley and Elston's patent, and the others (Fig. 3, 4, and 5), so far as we know, are public property.

Those of the second variety (Wakefield's patent) are illustrated by Figs. 6 and 7; here small holes admit the steam upon the back of the packing where it is expected sufficient pressure will be applied to make the packing tight; but we are of opinion that when these pistons have been found to be steam tight it was only by virtue of the elasticity of the packing itself.

For the two first varieties of pistons (Figs. 1 to 7) the body is generally of cast iron, keyed or screwed upon the piston rod, and the packing made of brass; sometimes, however, the piston rod and the body of the piston are forged solid in one piece, with the especial object of reducing the weight. This arrangement is, however, open to one very serious drawback, which militates against its general adoption, for, whenever the piston rod breaks or is permanently injured so as to require renewing, the piston itself must be renewed also, and the expense of repairs is thereby greatly increased.

Among pistons of the third kind, Fig. 8 illustrates Mr. Ramsbottom's patent, in which the body is made of cast iron, keyed upon the piston rod, there being three steel rings $\frac{5}{16}$ broad let into the body, and forming the packing. The adoption of this design of piston was most unquestionably one of the boldest attempts made at the simplification of the working details of the steam engine, but we can also say that its success is as complete, as it must have been unexpected to many. We have seen cylinders worn almost as bright as a mirror by the use of this piston without showing a single scratch, and, as it has been at work now for some seven years with similar results, this is ample proof of its efficiency; taking also into consideration its great simplicity and cheapness, we think that it should ere long find its way into general use. The secret of its tightness seems to us to be satisfactorily explained in the opinion advanced by some engineers, that a thin ring of condensed steam maintains itself between the walls of the cylinder and the piston, and serves to act as a packing; for, if this be really the case, the construction of the piston under consideration is evidently correct, since the two spaces between the three rings afford room for two such annular packings of condensed steam. Another description of piston of the third kind is Mather's, with helical packing; it is, however, only used in stationary engines, where, we believe, it is found to answer very well.

Piston rods, until very lately, were generally made of Yorkshire iron, and in some instances have been casehardened; they are now, however, very frequently made of steel; and should Krupp's cast steel become much cheaper, we do not doubt that they will then be made of steel invariably, though their diameter will not be much reduced on that account. We shall not attempt to give rules or formulæ for defining the diameter of piston rods; but in the table below we give a series of dimensions of piston rods, with corresponding diameters of cylinders, from the actual practice of various makers.

Designation of Engine, and Maker.	Diameter of Cylinder.	Diameter of Piston Rod.
	inches.	inches.
Sharp's London and Chatham Express	17	$2\frac{5}{8}$
Sharp's Great Western Express	16	$2\frac{1}{2}$
Ramsbottom's Express	16	$2\frac{1}{2}$
Ramsbottom's common Passenger	16	$2\frac{1}{4}$
Sharp's Dublin and Belfast Tank	12	2
Fairbairn's Wolverton Passenger	16	$2\frac{3}{8}$
Sharp's London and Chatham Goods	17	$2\frac{5}{8}$
Sharp's Dublin and Wicklow Goods	16	$2\frac{3}{8}$
Ramsbottom's Crewe Goods	17	$2\frac{1}{2}$
M'Connell's Wolverton Goods	16	$2\frac{3}{8}$
Fairbairn's Wolverton Goods	18	$2\frac{3}{4}$

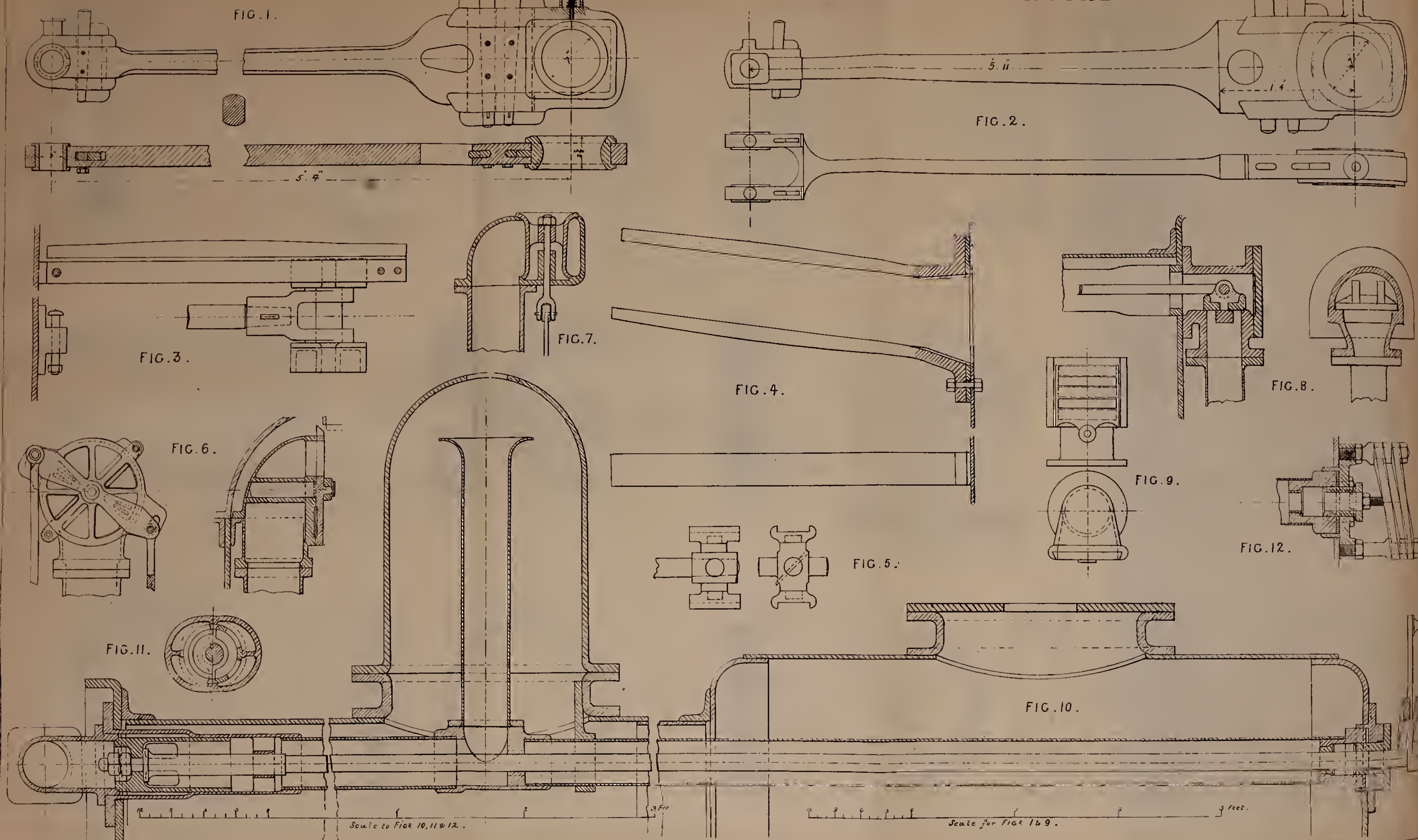
Connecting rods are generally illustrated by Figs. 9 and 10, Plate 238, and Figs. 1, 2, and 3, Plate 239; Fig. 9 being that for outside cylinder passenger engines; Fig. 2, Plate 239, that for inside cylinder goods engines, as made by Mr. Ramsbottom; Fig. 10, Plate 238 is the connecting rod as made by Messrs. Fairbairn in their common passenger engines and Fig. 1, Plate 239, that of Sharp's heavy goods engine "Sphynx." The smallest area of the rod proper is generally a little larger than that of the piston rod, and increases gradually towards the crank end. Connecting rods, and more especially coupling rods, are now generally made flat rather than round in section, on account of their greater elasticity, and of the greater facility possessed by them to yield when passing round sharp curves, or when they have to sustain and transmit severe concussions, either from unevenness of the road, or from sudden reversal of the engine. The brasses at the crank end are now generally lined with Babitt's metal, which has the advantage of keeping very cool during long journeys and at great speeds.

Crossheads and slide bars for outside cylinders, used by Mr. Ramsbottom for inside cylinders also, with a view, no doubt, of reducing the number of types, are illustrated by Figs. 4 and 5, Plate 239; those more generally used for inside cylinders are illustrated by Fig. 3. The slide blocks are generally made of cast iron, sometimes lined with Babitt's metal, and the slide bars are made of solid shear steel—very seldom of iron faced with steel.

The diameter of crank pins for coupling rods and outside connecting rods has increased gradually, as locomotive engineers have become better acquainted with what was really required, namely, large wearing surfaces. They generally range between $2\frac{3}{4}$in. to $3\frac{1}{2}$in.; but we perceive that Mr. Ramsbottom has made the working surface as much as 4in. diameter in his outside cylinder express engines.

The feed pump, which forms an integral part of the steam engine proper, is now gradually superseded by Giffard's injector, which is more handy; and when the driver is well acquainted with its peculiarities it is less liable to failure upon the road than the pump with its train of clack boxes. The

LOCOMOTIVE ENGINEERING.



W. Smith. C.E. direx.

injector is capable of performing not only the work of the ordinary feed pump, but also does away with the necessity for the donkey pump, which of late years had been a frequent adjunct to the locomotive engine.

Steam regulators also form part of the steam engine proper, and are generally of four kinds, viz.:—

1st. The regulator, with disc valve (illustrated by Fig. 6), which, until lately, has been used by Messrs. Sharp, Stewart, and Co. almost exclusively; it has, however, the defect, inherent to all disc valves, of wearing its faces convex, and of becoming leaky very soon; besides this, it is very expensive, being made wholly of brass, and for these reasons it is being gradually abandoned.

2nd. The regulator, with slide valve (illustrated by Figs. 8 and 9), of which the horizontal one is used in engines having no dome, the steam being collected in a long copper pipe, having a series of perforations on the top. In these regulators the head or body is generally of cast iron, and the slide valve of brass; they are very simple, require but little labour in fitting them up, and answer their purpose very well.

3rd. The regulator, with piston valve (illustrated by Figs. 10, 11, and 12), used chiefly by Messrs. Allan and Sinclair. They are worked from a handle, moving in two helical guides, and certainly have the advantage of not being subject to open or shut of their own accord; they are, however, a most expensive piece of workmanship, and that especially so because they require to be made wholly of brass.

4th. The regulator, with double-beat valve (illustrated by Fig. 7), first introduced, we believe, in some engines made for the Lancashire and Yorkshire Railway, by Mr. Fairbairn. They are now invariably employed by Mr. Ramsbottom, we presume especially on account of their non-liability to wear out. These regulators also require to be made wholly of brass, but are comparatively inexpensive in fitting up.

Before dismissing this portion of the subject, it remains for us to make a few remarks about the eccentrics. These may be generally illustrated by Fig. 20, Plate 238, and are from 2⅜in. to 2⅝in. broad, the sheaf of cast iron, in two pieces, bolted together with cottered bolts, and the straps of wrought iron, about 1⅛in. thick, with a brass lining about ⅜in. thick, fitted into them. Mr. Ramsbottom, however, now makes the lining of Babitt's metal, cast in an iron mould, and, we believe, does not put them into the lathe at all. These are found to wear much longer, and to run cooler.

(To be continued.)

J. F. SPENCER'S IMPROVEMENTS IN SURFACE CONDENSING MARINE ENGINES.

(Illustrated by Plate 237.)

We have at various times alluded in THE ARTIZAN to Mr. Spencer's improvements in marine engines, and particularly his construction and arrangement of surface condensers, and their adaptation to marine engines.

Amongst the numerous competitors for success in the application of surface condensation, the most successful is Mr. Spencer, and his success is not due to mere pushing business habits or puffing, but solely to the sound practical and scientific intelligence which he has brought to bear upon this branch of engineering, hence almost every step he has taken has been successful, and an improvement upon that which preceded it.

The subject which we have selected for illustration is a pair of 200 horse power inverted cylinder screw engines, constructed by Messrs. Denny and Co., engineers, Dumbarton, for the "City of Cork," a 1500 ton steam ship, and one of Inman's Philadelphia line. These engines have been designed by Mr. Spencer, in accordance with his latest patent, and for compactness and accessibility of parts, they are unequalled; and for steadiness and perfection of working and economic performance they cannot be surpassed.

We may observe that in consequence of each of the four pumps being both an air and a cold water pump; the strain on the piston is equal instead of being one sided, as is the case when there are only one cold water, and one air pump, worked direct from the main piston of each engine.

The pumps are greatly reduced in diameter, as 150 horse power engines require pumps of only about 9in. diameter to maintain a good working vacuum. The air pumps are well below the condenser; thus ensuring a free flow into them. The feed and bilge pumps are worked from the main cross head, instead of requiring extra space and gear or apparatus at the end of the crank shaft.

The total athwart ship's space occupied by engines on this plan of 200 horse power, is about 9ft.; and of 300 horse power, about 11ft.

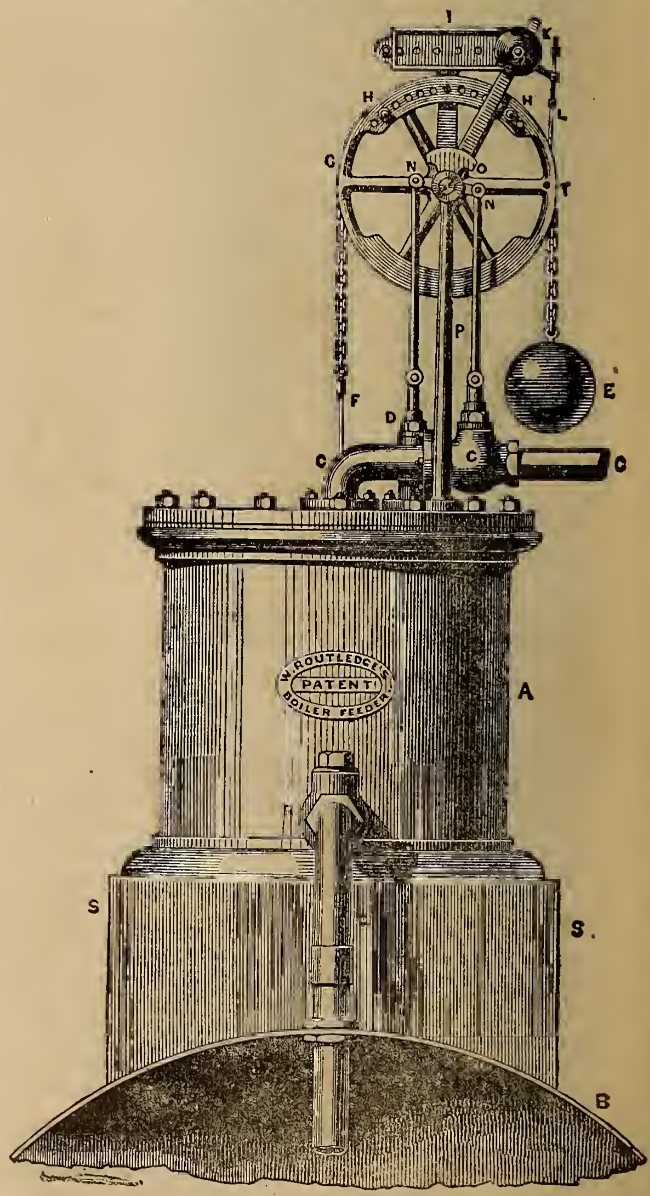
The surface condenser, which is constructed upon Mr. Spencer's patent plan, admits of ready access to the interior, and of the withdrawal and replacing of one or more tubes with the greatest facility, and without breaking a steam or vacuum joint. Whilst from the central position in which the condenser is fixed, great economy of space is effected, the condenser casing being employed in supporting the cylinders in combination with four wrought iron columns or pillars.

ROUTLEDGE'S PATENT SELF-ACTING BOILER FEEDER.

Continuing our notices of the contents of the late Exhibition, the accompanying engraving illustrates Routledge's Patent Self-Acting Boiler Feeder, manufactured by the firm of Routledge and Ommanney, of New Bridge Foundry, Salford, Manchester. Several of these self-acting feeders have, we understand, been at work for some time in the manufacturing districts and in London, and have been found to give very satisfactory results.

In our illustration, A is a closed vessel, containing a float. B, the boiler. C C C, Water supply pipe and valve. D, steam valve connected to boiler. E, balance weight. F, float wire. G, float wheel. H H, two studs in float wheel. I, a register. K, tumbler lever. L, link, connecting float wheel to register. N N, levers connected to water supply and steam valves. O, quadrant, keyed fast on lever shaft. P, standard. Q, feed pipe. R, feed valve. S S, feeder support. T, stud attached to link L to work the register.

Should the boiler require water, the float attached to the float wire F descends, putting in motion float wheel G, which brings the stud H in contact



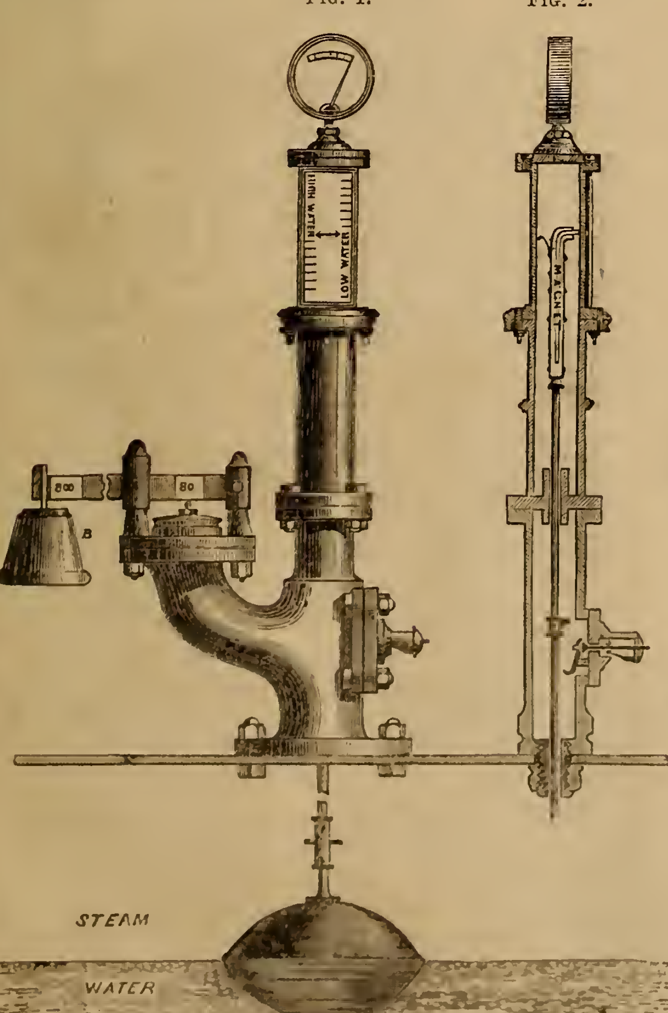
with the tumbler lever K, which, falling over, shuts the steam valve D and opens the water valve C, allowing the cistern to re-fill with water causing the float F to rise, and again opening the steam valve D, at the same time shutting the water valve C. When the pressures become equalised, the water descends of its own gravity into the boiler. The action of the apparatus is continuous. The position in which the float

wheel is represented in the annexed engraving shows the water to be descending into the boiler.

Amongst the advantages claimed to be derivable by the use of the self-acting Patent Feeder are the following, viz., that it will feed a boiler under any pressure of steam, and, when applied to two boilers, it will, when one is let off, fill it again by taking steam from that in work, the water being taken from the usual supply. It will feed with water at 212 degrees, and will fetch water from a depth of 20ft. below the feeder, if cold water, and warm water at 90 degrees, from a hot well or other source, 15ft. below the feeder. With a register attached it will show the quantity of water used. It possesses simplicity of construction, durability, and non-liability of derangement. It will work through the night, and keep a uniform height of water in the boiler. It also gets rid of the foul air, so that none can enter the boiler. The economy in fuel by using the feeder is found to be equal to 15 per cent. in the quantity used—that is, when cold water has been used to feed the boiler previous to the application of the feeder. The head of water required to form the vacuum is about one quarter of the quantity used, the remainder can be fetched by the vacuum from the hot well of the engine or any other source. The usual vacuum formed is 13lbs. An extra valve can be attached when the water is required to be fetched from a well or other source by the vacuum.

The Jury of Class 8 of the late Exhibition awarded a prize medal to Messrs. Routledge and Co. for the practical utility of this apparatus.

Fig. 1. Fig. 2.



MAGNETIC INDICATOR OF WATER LEVEL.

The accompanying woodcut, illustrates the Magnetic Indicator invented by M. Lethuillier-Pinel, of Rouen, and for which he received the award of Honourable Mention at the late Exhibition. Fig. 1 shows the Magnetic Indicator with alarm whistle, pressure gauge, and safety valve complete; Fig. 2 being a sectional view, showing the position of the magnet. In the latter figure we have not considered it necessary to repeat the view of the float in position.

The Magnetic Indicator establishes a communication between the interior and the exterior of the boiler, through the brass collar shown in Fig. 2, leaving the rod free, and rendering unnecessary conical and packed joints, and also avoiding the inconvenience and necessity of constant watching to see that the float acts.

A float proved to stand the pressure of fifteen atmospheres is joined to an iron rod, to the other extremity of which is attached a strong magnet which rises or falls in a brass box with the rise or fall of the water in the boiler. On the exterior of one of the sides of the box is placed horizontally an iron index or pointer, without any support, and held on the brass merely by the attraction of the magnet, which it follows in all its movements, running as it rises and falls on the face of the box, which is graduated to correspond with the proper height of water.

The superior or inferior limit of the float's course cannot be attained without operating upon the catch which opens the whistle, and immediately makes known the want, or excess of water.

Mr. Pinel's apparatus has already been very extensively used on the Continent, with very satisfactory results; and though, until last year, it was not known much in England, it is deserving of the attention of the users of steam power, as being an apparatus that will constantly and with certainly mark the height of the water in the boiler, and give warning when, through neglect or forgetfulness, it varies from its proper height.

R. GIBBON'S IMPROVED MACHINE FOR SEPARATING, CLEANING AND CRUSHING MALT.

This machine has been invented by Mr. R. Gibbon, a practical brewer of many years experience, with a view to overcome the disadvantages attend- the present comparatively rude and inadequate mode of crushing malt, as in consequence of malt in bulk containing at least three recognisable sizes of kernel, which it is impossible to crush effectually at the same time, and with such means, all the larger and most valuable kernels must either be crushed to atoms, and cause considerable waste, or the smaller ones entirely escape and go into the mash-tun useless. It being found that when malt is placed in a hopper in large quantities, the small kernels will, to some extent, get together, and come to the rollers in much larger proportions, at times, than the bulk shows, and thereby cause the irregularity noticed.

When a grist of malt is to be crushed, and on examination is found to be in a sensible proportion, hard and steely, if an adjustment of the rolls is provided, by which the setting can be matched to the average size of the steely grain, whether large, middle, or small, and this is at all times properly attended to, and a judicious mashing heat applied, these hard steely kernels will become thoroughly crushed and afterwards dissolved in the mash-tun.

It is a well known fact that malt cannot be reasonably crushed too fine for profitable purposes, provided the worts pass through the *goods* freely and quite bright, and one great object of this machine is to *thoroughly and effectually* crush every kernel, but *powder none*—a matter which, hitherto, it has been most difficult to accomplish. Indeed, it never has been accomplished effectually by one, or even two pair of rollers, and it appears to us that Mr. Gibbon's machine is admirably adapted for this purpose.

By this combined machine the malt is separated, in its descent through the upper small hopper, from its coarse impurities. It then passes a feed roll, which supplies the whole of the crushers. From the feed roll it falls through a gentle blast of air (which carries off all the dust) on to a couple of sieves, rapidly, but smoothly shaken, where a further separation of the malt from fine flints and small stones takes place; it then passes on, in its dressed state, to three separating sieves, smoothly shaken by the same machinery, by which it is sorted into three sizes, small, middle, and large and led into three small hoppers, conducting to the three pair of rolls, each adjusted to the size of malt it has to crush, these rollers being actuated by toothed wheels, keyed on one end of their axes, the whole series deriving motion from large spur wheels keyed on the axis of some of them, and primarily from ordinary fast and loose pulleys attached to a prolongation of the axis of one of the rollers. After passing the rollers, the crushed malt falls into small hoppers, either to be conducted into one large receptacle, or separate bins, as may be desired.

We may state that a grist of malt crushed as described by this machine, is calculated to produce from one to three per cent. more extract, at the least, than when crushed by one pair of rolls only, and we do not contemplate that a grist of malt, crushed by Mr. Gibbon's machine, will choke the false bottoms of the mash-tun, provided a proper mashing heat is first applied.

The rolls are chilled in casting and rendered almost as hard as steel, which gives them the power of crushing the small flints and stones which pass with the malt, without any indentation or injury, such as occurs to

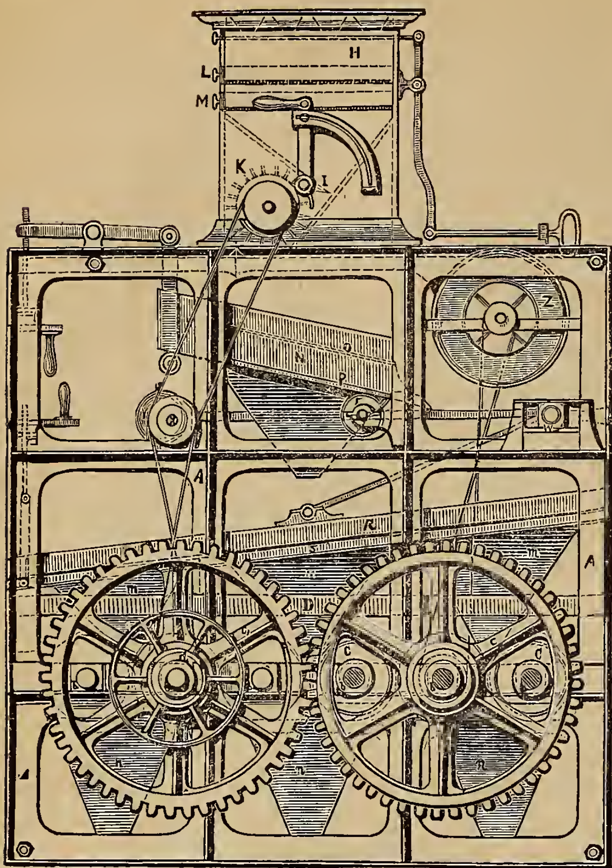


Fig. 1.—Side Elevation.

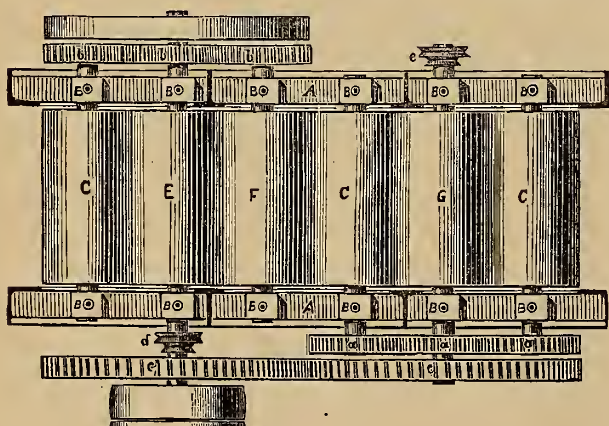


Fig. 2.—Sectional Plan.

tbe common soft rolls hitherto generally used. The journals are also hardened, and the bearings of cast steel. An improvement is also added for guarding against the back lash or jerking of the rollers when running empty. It is well known, that by the present mode of resting the journals of the rolls on the open brass bearings, a most disagreeable and injurious back lash takes place when running empty, the rolls striking each other with great force and injury, but which in the machine under notice, is entirely guarded against, so that they may run empty with as much safety as when at work. The easy shaking motion given to the sieves by an eccentric, is so arranged that it can be thrown on or off at any moment, with the rolls and machinery in motion, without the slightest injury. We have lastly to call attention to the valuing appendage, or malt-balance, attached to Mr. Gibbon's machine, and consisting of an adjustable balance such as an ordinary steelyard, by which the actual weight per bushel and quarter, as also the specific gravity of tbe grain can be at once determined, and thence its real value to the brewer.

Fig. 1 shows a side elevation of the machine, and Fig. 2 a sectional plan thereof. A is the cast-iron frame, having suitable receptacles for the bearing blocks B, and caps over each pair of rollers marked C, and which are moveable at pleasure. A cast-iron plate, D, is placed at the back of these caps, which extends the whole lengtb of the frame, and fits over the necks of tbe gudgeons and against the ends of the rollers. The rollers marked E, F, and G are fixed in place, the other three being movable and adjustable by means of set screws. Wedges are driven in behind each of the movable rollers to prevent the back lash, and are kept in place by set screws tapped into the back plates of the caps C. H is the upper hopper box containing the regulator valve I, the feed roller K, and the two sieves L and M, the latter being fixed in frames, so as to be readily withdrawn; N is the frame under tbe feed roller, containing two sieves O and P, the top one being coarse and the lower one fine, as before described. The spout, Q, is here sbown fixed, and conducts tbe grain to the separating sieves, which are placed in the frame R. This frame travels on the bars S, which are secured at the upper ends to the frame of the macbine, their lower ends being supported by an adjusting screw for altering the inclination. These bars carry rods, upon whicb tbe cleaners revolve, and which consist of thin discs of metal placed between the wires of the sieves. These sieves are shaken by means of a lever, keyed or otherwise attached to the shaft V, which latter is worked by the eccentric Y on tbe shaft X, which also carries an eccentric for working the sieve frame N. This eccentric is connected with the slide bar W, a plan of part of which is shown in Fig. 3. Z is an ordinary fan for driving off the refuse from tbe grain as it falls from the feed roller. The dust is driven out of tbe spout Z, which has a slot in it for the grain to pass through on to the sieve O. Three pinions (*a a a*) for driving the rollers are placed on one side of the frame, and three (*b b b*) on the other, as they would not gear well if all placed on the same main driving wheels *c c*, one of which it is preferable to make a mortice wheel. The hoppers for supplying the rollers are fixed in a frame *m*, and those for receiving the crushed grain in a frame *n*; they may all, however, be separate. The frame N rests upon small wheels, which are carried by vertical bars to place the frame at any convenient angle. The weighing machine may be placed anywhere convenient.

Fig. 3.

Mr. Gibbon has compiled a series of comparative tables to be used in connection with the valuing appendage, and by the aid of which the value of malt and barley may be readily deduced; the following is an example of these tables.

Barley, weight per bushel in lbs. ...	51·5	52·5	53·5	54·5	55·5	56	57	58
Barley, weight per sack or comb in in stones of 14lb.	14·10	15	15·4	15·8	15·12	16	16·4	16·8
Barley, weight per quarter	412	420	428	436	444	448	456	464
Malt, weight per bushel	38	38·75	39·5	40·5	41·75	43	44	45
Malt, weight per quarter	304	310	316	324	334	334	352	360
Malt, specific gravity or solid extract, per quar. .	1·205	1·216	1·226	1·240	1·253	1·270	1·283	1·297
Malt, density of wort obtainable, per quarter	76	80	84	89	94	100	105	110
Malt and barley, increase in value per quarter to brewers	0	6*s.*	12*s.*	19*s.* 6*d.*	27*s.*	36*s.*	43*s.* 6*d.*	51*s.*

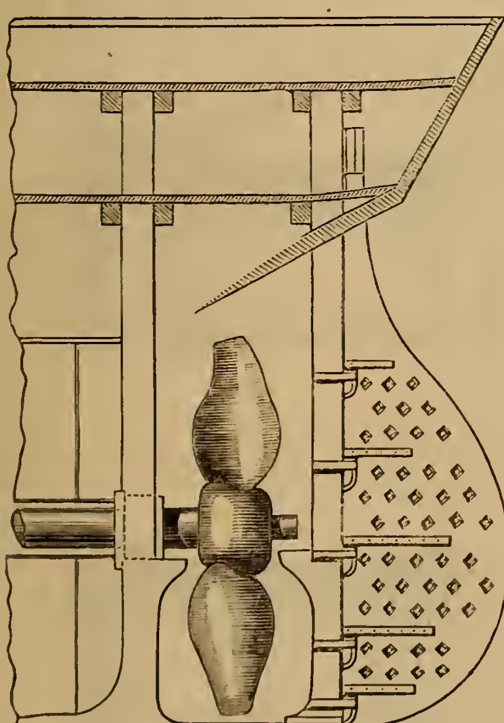
A modification of the arrangement illustrated in the annexed wood-cuts, may be made by placing three rollers on the same spindle, these rollers working opposite to a second set of three rollers fixed to a second spindle. In this arrangement, each pair of opposite rollers is made of a different diameter (about the twenty-fifth part of an inch), so that when tbe largest rollers are working close together, or nearly so, and thus allowing the smaller grains to be properly crushed, the next pair of rollers would be slightly separated so as to properly crush the medium sized grain, whilst the third pair of rollers would be still further separated so as to properly crush the larger grains. The three rollers instead of being cast separately, may be cast together so as to form a single roller, and be afterwards turned to the required diameters. And instead of the rollers of each pair being the same size, as just described, the difference of diameter to allow for the different sized grains, may be made in the roller or rollers upon one of the spindles only, the roller or rollers on the otber spindle being parallel

throughout; or lastly, part of the difference may be made in the rollers upon one spindle, and part in the rollers upon the second spindle, either of these latter arrangements giving a slight rubbing action to the grain as well as crushing it.

PERFORATED RUDDERS.

Commander T. E. Symonds, R.N., lately submitted to the Admiralty a very simple, yet valuable improvement in rudders. The object to be attained more especially being to render the rudders of screw ships of war and armour-plated vessels, more easily worked and manageable, as considerable difficulty has hitherto been experienced in steering this class of vessels, and which is attributed no doubt in a very considerable measure to the imperfect proportions of the rudders at present in use.

Capt. Symonds proposes to make a series of perforations in the rudder, as shown in the accompanying woodcut. The orifices increase in size from the centre of the thickness of the rudder on either side, and expose a series of surfaces when the helm is over. These openings allow of a free passage of the water through the rudder, at the same time preserving a more effectual surface for steering, when the rudder is by these means got over



more readily to a greater angle; the water impinging on the rudder in a horizontal direction, and acting on the faces of the holes or slots. Again, it may safely be assumed that in case of a ship gathering sternway before the helm could be righted, or in the event of the rudder being struck by a heavy sea, the shock and damage which would ensue in a vessel fitted with the ordinary rudder is averted, and thus the ship may be kept steadily to her bearings in the heaviest weather.

The plan is certainly one which possesses considerable merit, and is worthy of the attention of those entrusted with the designing and construction of our costly, and it is also to be feared, experimental vessels of war. (We are informed by Capt. Symonds that junks and large vessels in the Chinese waters are now, and have been for numbers of years back, fitted with these perforated rudders.)

DR. NORMANDY'S APPARATUS FOR THE DISTILLATION OF SALT WATER.

The annexed woodcuts (p.p. 80,81 illustrate the very useful apparatus invented by Dr. Normandy, for the production of aërated fresh water from sea-water.

The apparatus under notice is the result of very considerable study, and a series of most carefully conducted experiments undertaken by Dr. Normandy, with a view to arrive at a comparatively simple and efficient plan of producing distilled water from sea water, which should not possess the disadvantages attending, to a greater or lesser extent, all methods previously adopted for the production of distilled water from sea water. We allude to the intolerably nauseous and empyreumatic taste and odour which it retains for many weeks, and which is, moreover, insipid, flat, and vapid, owing to its want of oxygen and carbonic acid, which water in its natural state possesses, and of which it has been deprived by the process of distillation.

The problem which Dr. Normandy undertook to solve was the following, viz., to obtain, with a small proportion of fuel, large quantities of fresh, inodorous, salubrious, aërated water, without the help of machinery or of chemical re-agents, by means of a small, self-acting, and compact apparatus, capable of being worked at all hours, under all latitudes, in all weathers and conditions compatible with the existence of the ship itself, and incapable of becoming encrusted, or otherwise going out of order. That the problem, through necessarily a difficult one, has been satisfactorily solved in the apparatus before us is best evidenced in the general use into which the apparatus has gradually come, after having been submitted to the most severe competitive trials, made in 1859, against the ordinary condensers used in the Navy.

Referring to the annexed illustrations, the apparatus, it will be seen, consists mainly of two parts—an evaporator and a condenser, joined so as to form one compact and solid mass, screwed and bolted, without solderings or brazings of any kind. The evaporator is a cylinder, partly filled with sea water, into which a sheaf of pipes is immersed, so that on admitting steam at a certain pressure into these pipes, it is condensed into fresh, though non-aërated water, by the sea water by which the pipes are surrounded, the sea water being thus heated and a portion of it evaporated at the same time. This non-aërated fresh water becomes aërated by an arrangement which we will afterwards explain.

The steam at a pressure being of course hotter than ordinary boiling water, serves to convert a portion of the water contained in the evaporator into ordinary steam, which, as it reaches the pipes in the condenser, is resolved therein into fresh aërated water without pressure. By thus evaporating water under a slight pressure, one fire performs double duty; and thus the first condition, that of economy, is fulfilled; for while, in the usual way, 1lb. of coal evaporates 6 or 7lbs. of water, the same quantity and quality of coals, burnt under the same boiler, but in connexion with this apparatus, is thus made to evaporate 12 or 14lbs. of water, or in other words, from the same amount of steam or of coals employed, this machine will produce double the quantity of fresh water that can be obtained by simple or ordinary distillation—that is to say, double the quantity produced by the ordinary condensers.

The steam issuing from the evaparator, and which is condensed by the water in the condenser, imparts, of course, its heat to the sea water in it; and as this water is admitted cold at the bottom, whilst the steam of the evaparator is admitted at the top of the condenser, the water therein becomes hotter and hotter gradually as it ascends, and when it finally reaches the top, its temperature is about 208° Fahr.

As water begins to part with its air at a temperature of about 130° Fahr., therefore, the greater portion of the air condensed in the water which flows constantly and uninterruptedly through the condenser is thus separated, and led through a pipe into the empty space left for steam-room within the evaparator, where it mixes with the steam. And as about six gallons of sea water must be discharged for every gallon of fresh water which is condensed, and as each gallon of sea water contains five cubic inches of air, and whereas the utmost quantity of it that fresh water can naturally absorb is fifteen cubic inches per gallon, it follows that the steam in the evaparator, before it is finally condensed, has been in contact with twice as much air as water can take up, the result being a production of fresh water to the maximum of aëration.

The agent employed for the destruction and removal of the empyreuma of distilled water thus aërated, is charcoal, Dr. Normandy having found, from carefully conducted experiments, that two cubic feet of charcoal are sufficient to remove entirely the empyreumatic odour and taste of distilled water, produced at the rate of 500 gallons per diem, and that the charcoal never wants removing. And the water issuing from the apparatus is perfectly sweet, tasteless, inodorous, and completely saturated with a large quantity of oxygenised air and of carbonic acid.

The apparatus represented in the accompanying drawings is intended for sailing ships; that is to say, when it is placed on deck, or above the level of the sea, on deck or on land—in which case it must be provided with a lift-pump, and of course with a steam boiler.

Fig. 1 is a section showing the construction of the apparatus without reference to the real position or actual form of its constituent parts.

Fig. 2 is a front view of the apparatus, one sixteenth of the real size, and of the normal power of 500 gallons per day of 24 hours.

Fig. 2 is a back view of the same apparatus.

The action and mode of working the apparatus is as follows:—Get steam up in the boiler, start the pump, and fill the apparatus with sea water by opening the cock A; the sea water pumped up will then enter the condenser at B, and pass through feed-pipe C into the priming box, D, and thence into the evaporator, E, where it should be allowed

NORMANDY'S APPARATUS FOR DISTILLING SALT WATER.

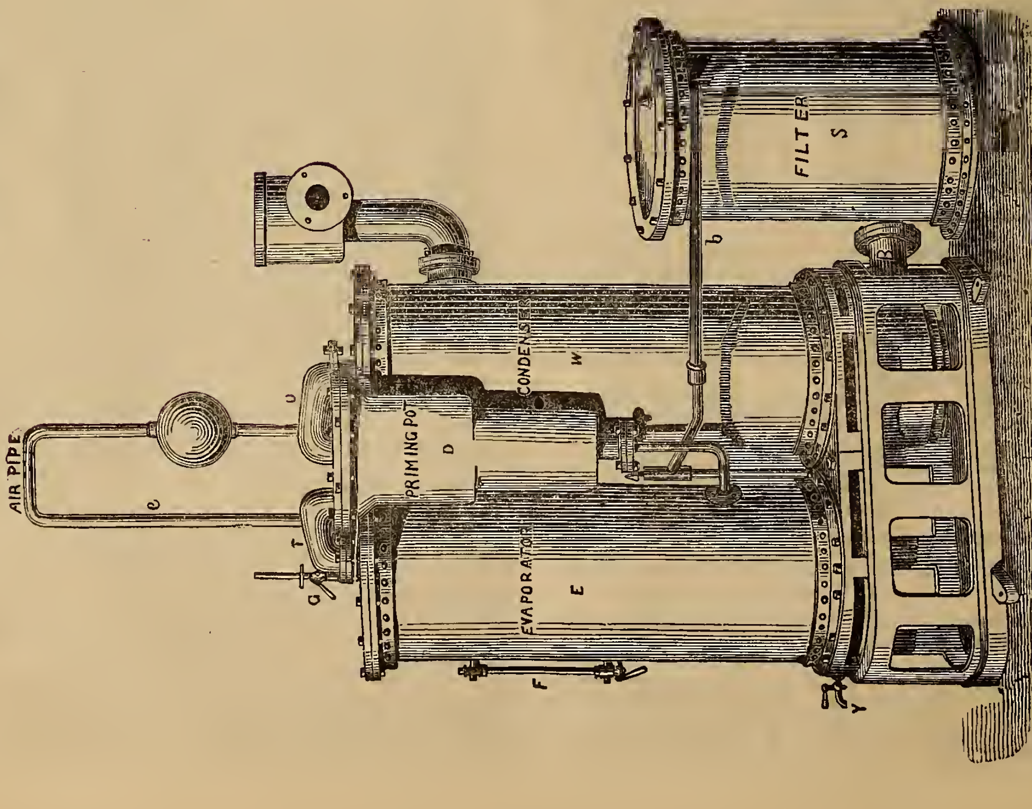


Fig. 2.

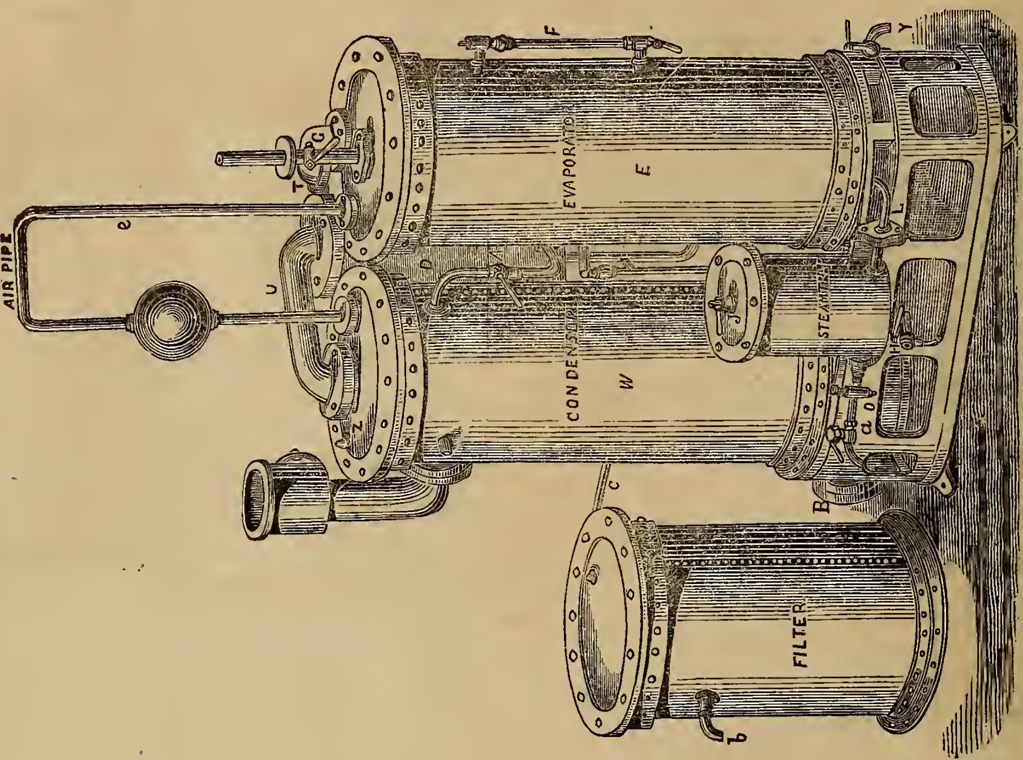


Fig. 3.

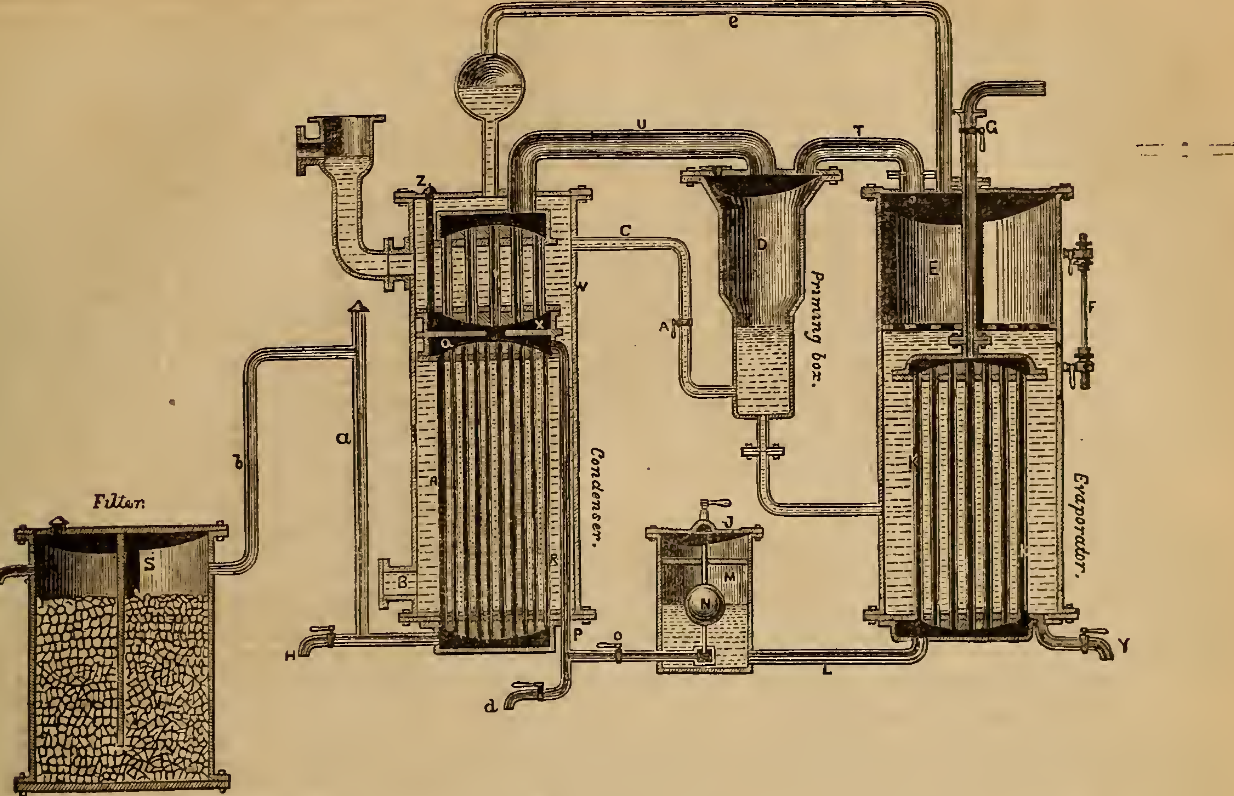


FIG. 1.

to rise half-way in the glass gauge, F, when the cock, A, should be shut. The apparatus having its proper quantity of sea-water, open the steam cock, G,* and likewise the clearing cock, H; after a short interval open also the small cock, J. On opening this cock, J, some water will perhaps be projected for a few seconds; but, presently, air and steam only will issue from it; as the steam is seen issuing from it, it should then be closed gradually, and eventually be left almost shut, so as to leave only room for the smallest possible wreath of steam slowly to issue from it. As soon as the steam-cock, G, is open, the steam from the boiler will rush through that cock into the sheaf of pipes, K, of the evaporator, in which pipes it will be condensed by the sea water which surrounds them, and then flow through the pipe L into the steam trap, lift up the float, N, pass through the cock O, ascend the pipe P into the upper cap, Q, of the refrigerating sheaf of pipes R, and flow out at the waste cock H. If the apparatus has been left for some time without working, the water issuing from the waste cock will have a rusty colour, wherefore it (the condensed water) should be left running until it flows out clear, in order not to foul the filter. As soon, however, as the water flows in a clear state, shut the cock, that the water may pass into the filter S.

The steam within the sheaf of pipes K of the evaporator E soon brings the sea water round them to the boiling point, and the attendant may know that it begins to boil by a slight up and down motion of the water in the water gauge. Steam passes then from the evaporator through the pipe U into the priming box L, where any salt water which may have been carried with the steam is deposited and returned into the evaporator, while the pure steam passes from the priming through the pipe U into the sheaf of pipes V of the condenser W, and being there condensed falls into the lower cap X, and thence from the upper cap of the refrigerating apparatus mixes with the water from the condensation of the steam of the boiler brought by the pipe P, and both waters pass into the filter S. As soon as the water of the evaporator begins to boil, open the brine cock Y, but only to such an extent as to permit a quantity of brine ta be constantly flowing from it. Open also the feed cock A, from time to time as the sea water in the glass gauge sinks, or adjust it so that no more sea water may flow through it than is sufficient to keep the gauge glass about half-full.

Attention to this is absolutely necessary; for, if too much or too little sea water be allowed to run out, the apparatus in the first case will not produce its proper quantity of fresh water, and in the second case earthy matter would be formed, which would impair the apparatus, or even put it altogether out of service. If, however, the attendant take care to adjust the brine cock X, so that the flow of the brine is at the rate indicated, that is to say, about one-third at least of the whole fresh water produced, there will be no chance of diminishing the evaporation, nor danger of incrustation.

If the fresh water produced is not sufficiently cool, work the donkey pump faster.

If any steam or water is seen to issue from the breathing pipe Z, it is a sign that too much steam is admitted into the apparatus, wherefore the steam cock should be shut off, more or less, so as to reduce the quantity of steam to the proper degree.

On board steamers, or when the apparatus is placed below the level of the sea, the stand pipe is suppressed, as well as the lift-pump; the large pipe and the upper pipe to which the stand pipe is bolted are then put in communication, through the walls of the ship, with the sea water outside, by means of the ordinary Kingston or ground valves of the ship, and in that case the air-pipe must of course be raised several feet above the sea level.

We may add that this apparatus was exhibited in Class B of the late International Exhibition, and that the exhibitors received a prize medal for it.

* This steam cock should be opened gradually, and only to such a degree as will not cause the sea water in the boiler and in the evaporator to boil furiously, which might produce extraordinary priming. Priming can always be easily prevented both in the boiler and in the evaporator by shutting the steam cock more or less.

INSTITUTION OF CIVIL ENGINEERS.

ON AMERICAN TIMBER BRIDGES.

By Mr. J. R. Mo[illegible], M. Inst. C.E.

It was stated that the early common road bridges for spans of 100ft. and upwards were generally built on the lattice plan. The sides and the top and bottom chords were formed of planks, usually 12in. wide by 3in. thick, fastened together by oak treenails, 2in. in diameter. For road traffic with moderate spans this kind of bridge answered tolerably well, and several of the early railway bridges were constructed in a similar way. But this structure, having been found insufficient for heavy trains, had long since been abandoned, though it was [illegible], but erroneously, thought in England to be the general style of American bridges.

The next design noticed was the Howe bridge, a detailed description being given of one on this principle on the Danville Railway, over the James River, at Richmond, Virginia. This bridge consisted of eleven openings, each 121ft. span, the total length being about 1800ft., with a width of 18ft. For each span there were two trusses, the greatest depth of which was 20ft. Each truss was divided into several panels 11ft. wide, and the bottom chords were so arranged that there should be only one joint in the chord pieces in each panel. The sectional area of the upper chords was 396 square inches, and of the bottom chords 528 square inches; the greater area of the latter being on account of the numerous joints. There were four main braces at the ends of each truss, and by means of three vertical iron tie-rods in each panel, any required camber could be easily given. Counter-braces were also introduced, by which, when keyed up, the bridge could be so stiffened that a passing load was said to produce no additional strain. These bridges were always built of the best white pine, and the ordinary price for a single line, including erection, was from £4 to £5 per lineal foot. The usual quantity of timber employed was about 30 cubic feet per lineal foot, and the weight, including iron work, a little more than half a ton per lineal foot. Assuming a load of 3000lbs., including its own weight, to be uniformly distributed over the bridge alluded to, the strains would be, by the ordinary calculation,

On the upper chords, compression,	729 lbs.	per square inch.
„ bottom chords, tension,	547 lbs.	„
„ end braces, compression,	735 lbs.	„
„ end tie-rods, tension,	15,125 lbs.	„

The ordinary dimensions of a bridge on this principle having a span of 150ft. as built on the Portland Railway, were then given, from which it appeared that the lower chord pieces of the two trusses had together a sectioal area of 676 square inches, and of the upper chord pieces of 520 square inches. Assuming the same weight of 3000lbs. per lineal foot to be equally distributed over this structure, the strains would be,

On the upper chords, compression,	901 lbs.	per square inch.
„ bottom chords, tension,	694 lbs.	„
„ end main braces, compression,	750 lbs.	„
„ end tie-rods, tension.	18,750 lbs.	„

These strains were greater than in the first example, and the compression of 901 lbs. per square inch on the upper chords was the limit of safety; but it was not probable that the bridge would ever be loaded to the amount assumed.

Owing to the increased weight of the trains and the greater span of railway bridges, it was afterwards found necessary to strengthen this form of bridge, by the addition of arches on the sides of the trusses. This "Improved Howe Truss," as it was usually called, came into general use. A bridge on this plan was described, which was built for a double line on the Philadelphia and Reading Railway, where it was subject to the heaviest traffic in America, the coal conveyed over it alone, exceeding 5000 tons daily, besides the ordinary passenger and goods trains. This bridge had a clear span of 160ft. There were three trusses, each 23ft. deep, and six arches. The sectional area of the three upper chords was 1215 square inches, of the bottom chords 1620 square inches, and of the six arches 1530 square inches. The arches were formed of the best pine, in pieces about 24ft. long by 4½in. wide and 15in. deep. Timber arches had not unfrequently been built of pieces 6in. square; but very rarely of laminated plank, in the manner formerly practised in England. Supposing a load of 3 tons per lineal foot, including the weight of the structure itself, to be equally distributed over this bridge, and to be borne both by the upper chords and the arches, then the compressive strain per square inch would be 292lbs. on the former, and 237lbs. on the latter; while if sustained by the arches alone, the pressure would only amount to 468lbs. per square inch. As American engineers usually considered 900lbs. per square inch as the safe limit of compression on timber framing, the strength of this bridge appeared, by calculation, to be greatly in excess of what might be deemed necessary.

The approximate quantities of materials in this bridge, exclusive of the roof, were, per lineal foot, 58 cubic feet of timber, 270lbs. of wrought iron, and 76lbs. of cast iron; and the cost of the superstructure amounted to £10 3*s.* per lineal foot.

These bridges were usually built with a camber of about 1 foot; but owing to decay at the joints, and the unseasoned state of the timber when framed, they soon deflected, and did not last in good condition longer than from twelve to fifteen years. When, however, they were roofed in and boarded at the sides, and were properly cared for, their duration might be taken at twenty-five years.

Some American engineers did not approve of the arch in combination with the truss, believing that a structure composed of two systems, neither of which was strong enough by itself, was wrong in principle, and that it was almost impossible so to proportion the strains, as to make each system bear its due share. These engineers thought it better, either to add to the truss the material used in the arch, or to depend entirely upon the arch, and to have a light truss merely to stiffen the roadway.

Timber-bridge building had become a special branch of engineering in America, and one firm alone—that of Mr. D. C. McCallum,—had constructed 15 miles on length of bridges upon different railways, in spans varying from 30ft. to 260ft. These bridges were built on what was termed the "Inflexible Arched Truse" principle; and a description was given of a bridge, for a single line of railway, 200ft. span, of which several had been erected in the States of New York, Ohio, and Mississippi. The principal dimensions were, total length, 210ft.; span, 200ft.; depth of truss in the centre, 26ft. and at the ends, 21ft. The arched tops of the two trusses had together a sectional area of 814 square inches, and the two bottom chords of 468 square inches. There were four main braces, which projected 32ft. from the piers, having a sectional area of 704 square inches on each side. The posts, of which there was a double row, inserted between the chords, varied from 9in. by 13in. at the abutments to 9in. by 6in. at the centre; the counter braces being 9in. by 6in. throughout. Special attention was directed to the manner in which the bottom chords were scarfed, by long splicing pieces and combination keys, so as to prevent them, as much as possible, fron stretching. The spur arch braces also transferred the load directly on to the abutments, by which the span was directly reduced to 136ft., so far as the strain on the truss was concerned. This bridge contained 7360 cubic feet of timber, 6958lbs. of wrought iron, and 5997lbs. of cast iron. Its total cost was £5 4*s.* per lineal foot; the rough timber being delivered on the site of the works at one shilling per cubic foot. The total weight, including the permanent way, was 109 tons, and with an additional load of 205 tons, equally distributed, the pressure on the arch top would be 862lbs., and the tension on the bottom chords would be 1500lbs. per square inch. With an actual load of nearly one ton per lineal foot, this bridge deflected nearly three-quarters of an inch, previous to the adjustment of the counter braces; these were then screwed up, and the load was removed, when a permanent deflection was found to be nearly five-eighths of an inch.

Several railway swing bridges of 120 feet span, had been constructed of timber by Mr. McCallum, and the principal dimensions, as well as detailed drawings, of one on a similar plan, proposed to be erected over the Mississippi river, at Clinton, Ohio, were given. A McCallum common road bridge, of 150 feet span, was then described; and it was stated that the quantity of timber in such a bridge, 29 feet in width, did not exceed 23 cubic feet per lineal foot, its entire cost amounting only to £3 2*s.* 6*d.* per lineal foot, the rough timber delivered on the ground being estimated at ninepence per cubic foot.

As an illustration of the adaptation of the Howe truss for large roofs, a description was given of that erected at the Dunkirk station of the New York and Erie Railway, the span of which was 80 feet. This roof was chiefly remarkable for the lightness of the scantlings, only two pieces of timber being as large as 6 inches by 7 inches, and most of them were about 5 inches by 7 inches. A principal of this roof contained 280 cubic feet, and would cost, at the ordinary price for timber framing, including erection, about £36.

In conclusion, the author expressed the hope that these specimens of timber work, the result ot many years' experience, and the adaptation of the only available resources of a new and comparatively poor country, would be found interesting; as, whatever their merits or faults, the bridges had undoubtedly produced good practical results, and would bear investigation.

ON THE RECONSTRUCTION OF THE DINTING AND THE MOTTRAM VIADUCTS.

By Mr. W. Fairbairn, F.R.S., M. Inst. C.E.

After alluding to the many advantages resulting from the application of a tenacious but flexible material, like wrought-iron, either in the tubular girder, or other forms in which it was now employed, as being probably the most suitable for bridges and viaducts of great width and span, where strength and durability were required, the author remarked, that at the present time there did not appear to exist any inducement, on the score of economy, for the introduction of a perishable material, such as timber, into structures intended to be of a permanent character. He then briefly described the original condition of the Dinting and the Mottram viaducts, on the Sheffield and Manchester railway, which were erected in the year 1843-44, under the direction of the late Mr. Joseph Locke. The former consisted of five arches of 125 feet span, and the latter of one arch of 150 feet and two of 125 feet span, constructed of timber ribs on the laminated principle. As was generally the case with similar structures, within ten or twelve years after their erection, the timber was so much decayed as to endanger their security, and to render considerable repairs indispensable. It was then contemplated to substitute iron work, but this step was not finally determined upon until the year 1858, when the viaducts were again in such a state as to alarm the passengers. It was stated that, the restored portions for each viaduct, consisted of two longitudinal and continuous tubular iron girders, fixed to the middle piers, and free to

expand and contract in the direction of the abutments. To the top of these girders iron cross-beams were rivetted, on which were laid the ongitudinal sleepers for supporting the rails. There was nothing new in the construction of the girders. They were one-thirteenth of the span in depth, and the areas of the top and bottom flanges were in the proportion of 7 to 6, the breaking weight, equally distributed, amounting to 12·58 tons per lineal foot. The chief novelty was in the mode of erection, and in the method of substituting iron for wood; the Directors of the Railway Company having insisted on the condition, that the traffic should not be interrupted during the progress of the works. Several plans were proposed, but that which was ultimately adopted was to construct the girders on the old existing platforms, to cut down the piers and the abutments, and then, by a simple mechanical apparatus, first to suspend and afterwards to lower the girders into their places. A strong wooden frame, about 16 feet high, was erected on the pier at each end of the girder, and on the top of this was inserted a cast-iron plate, with a hole in the centre, through which a square-threaded screw, 4½ inches in diameter, was passed. Centered on this screw, and resting on the cast-iron plate, was a bevil wheel, which received motion from a pinion, in connection with spur gearing, worked by crank handles in the ordinary manner. On the lower end of the large screw was forged an eye, to receive a cross-bar, having links at each extremity, which hooked under the angle irons at the sides of the girder. With six men at the handles, each girder was raised and lowered into its place in one hour. When one line of girders was thus completed—the whole of the traffic having in the meanwhile been carried by a single road—a temporary way was laid upon this line of girders, and the traffic was transferred to it. The girders on the other side of the viaduct were next constructed, and when they were finished, the iron cross-beams were rivetted to these girders, and the permanent way for this line was made good. The trains were again passed on to this road, the permanent way on the other side was laid, the timber arches and the framing were removed, and the viaduct was complete.

ON THE PERENNIAL AND FLOOD WATERS OF THE UPPER THAMES.

By the Rev. J. C. Clutterbuck, M.A.

The object of this communication was to draw attention to the nature of that portion of the water-shed of the Thames comprising the oolitic district, and containing a computed area of 1500 square miles, situated between the range of chalk hills bounding the Vales of Aylesbury and of White Horse, and the Cotswold Hills bounding the Vale of Evesham and the Valley of the Severn. It was shown that, the Thames ran almost entirely over a clay bed from its source, about 4 miles west of Cirencester, to its junction with the Thame stream, the limit of the district under consideration; and that it was the mere carrier of waters, whether perennial, or flood, brought in by its tributaries, a description of which, in the order they joined the main river, was given. Those running from N. to S. and from N.W. to S.E.,—as the Churn, the Coln, the Leach, the Windrush, the Evenlode, and the Cherwell,—received their perennial waters from oolitic strata. Those flowing from S. to N. originated in the chalk hills, from the escarpment of which they conveyed the back drainage, slightly augmented by that of the upper greensand, and then passed over the gault and kimmeridge clays, either to the main stream, as the Ray and the Cole, or as affluents of the Ock and the Thame, from which the principal supply was derived.

The geological condition of the source of the main stream was next noticed; and it was stated that the whole natural bed of the river, from Somerford Keynes to Sandford, below Oxford, was an excavation in the Oxford clay, flanked to the south by the escarpment of the coralline oolite, which rested on a ridge of the clay. As a rule, the lower levels of the valley, including also in many places the oolitic rock, outcropping to the north at a very slight angle beneath the Oxford clay, were covered with drift gravel. Whenever the floods had extended, sand, silt, or argillaceous loam, had been deposited on this gravel; and this action was still going on, governed by the number and character of the floods. Thus, the bed of the river was as a rule gravel, and the banks a warp, the accumulation of ages. There were instances of the change of bed to the extent of several chains in width; and indeed there appeared to be no limit to these deviations, but the physical features of the valley. These facts had an important bearing on any improvement, so much needed, in the drainage, or condition of the Thames valley.

The perennial waters were either used for mills, or for navigation. The mills on the tributaries were numerous. Between Thames Head and Cricklade they were, however, virtually deprived of water. From Cricklade to Lechlade the water was not applied to any economical use; and again from Lechlade to Wolvercote, 3 miles above Oxford, there were no mills. The gaugings of the numerous tributaries, where they joined the main stream, would give the aggregate of the water that it carried; but such observations had been neglected, and as the watersheds were very varied, any estimate of the volume of these streams at different seasons would be difficult. Most of these tributaries were immediately affected by heavy rains, and were subject to flood. The gauging of the main stream was beset with other difficulties; as the height and passage of the water was divided between the mills and the navigation, controlled, indeed, by stringent regulations, but too often disregarded. Though it was not the purpose of this communication to deal with absolute quantities derived from the various sources, yet it was believed the following gaugings, the result of several years' observations, by Mr. Stacy, the manager of the mills at Wolvercote, would be received with interest, and would, if carried in out in other places, lead to valuable results. There were no mills for 30 miles above Wolvercote, and the navigation, though 'flashes' were still sent down, had virtually ceased. Mr. Stacy had found that, in the summer months, the river had a mean velocity of 58ft. per minute, when the total yield was 8120 cubic feet per minute, exclusive of the quantity brought down twice a week by "flashes," which it was difficult to estimate· During the winter months, in fine weather, without frost, or rain, the river had a mean velocity of 94·9ft. per minute, and taking the section area as 181·5 square feet, this gave a volume of 17,224 cubic feet per minute. In moderate rainy weather, without floods, when the level of the river just reached the high-water navigation mark, the total quantity of water passing through the mill was 28,189 cubic feet per minute. At the end of December, 1862, under similar conditions, the total yield was 35,498 cubic feet per minute, of which 7738 cubic feet might be taken as the water passing from the main stream to Wytham. These data suggested the necessity of adopting a standard at various stations, so that the results might be compared with the rainfall when the gaugings were taken. At the same time, observations were made on the river below the influx of the Cherwell and the Ock, when the yield was found to be 50,995 cubic feet per minute, being an excess of 15,497 cubic feet as compared with Wolvercote, and of which excess it was estimated that 7689 cubic feet were brought in by the Cherwell, and the remainder by the Ock and the smaller perennial streams. The verification of these quantities was prevented by a fall of rain of nearly half-an-inch, in a few hours, which, at the expiration of thirty-six hours, doubled the volume of the Thame stream, and added about 30 per cent. to the volume of the main river. At Wolvercote, on the 5th of January, 1863, after about 1 inch of rain, the increase was from 27,986 to 48,418 cubic feet per minute. The rainfall from the 1st to the 7th January, 1863, inclusive, produced a flood in the Thames under circumstances peculiarly favourable for observation. The rain recorded during this period averaged 1·61 inch over the whole water-shed; Dalton's gauge, at Hemel Hempsted, showing a fall of 1·52in., and a percolation of 1·10in. The gaugings of the main river at Wolvercote then amounted to 82,500 cubic feet per minute, and at Clifton Hampden, below Abingdon, to 181,832 cubic feet per minute. Of this latter quantity 44,755 cubic feet were delivered by the Cherwell (or an increase of 37,066 cubic feet as due to the flood), 24,864 cubic feet by the Ock, and 29,713 cubic feet by the many smaller streams, water-courses, and land drainage outfalls, issuing into the river between Wolvercote and Clifton Hampden, a distance of about 20 miles by the river, with an average fall of 2ft. per mile, from a computed water shed of 80 square miles. It should be stated, that the rainfall on this occasion, on the southern part of the district, was in excess of the average more than half an inch.

The state of the navigation between Lechlade and Oxford was then described. It was remarked that from running on one stratum, the Oxford clay, and from other causes, it ceased to be; although the physical condition of the river bed, and its easy gradients, offered facilities for navigation, for the whole fall in this distance, 31 miles, was only 51ft. 3in., or about 1ft. 7½in., on average per mile.

The highest recorded floods on the Thames, since January 8, 1734, were then alluded to, and details were given of that which occurred March 29-31, 1862. The action of land drainage on flood-water was next considered. It was generally admitted, that the floods in the main river and its tributaries rose more rapidly than formerly; there being in some localities an advance of twenty four in seventy two hours within twenty years. There was a difference of opinion as to the subsidence of the water. As yet, however, it was believed, that land drainage had produced little apparent practical effect on the volume of the flood or perennial waters of the Upper Thames.

There was great scope for improvement in the valleys of the Thames and its tributaries, especially the Thame, the Ock, the Cherwell, and the Evenlode. With a view to prevent injury by floods, Mr. Bryan Wood had successfully carried out several important works, based on a system in which the local drainage was separated from the flood. If, by some such plan, the floods were brought under control, and the water prevented from remaining stagnant on the land, property would be improved, and the sanitary condition of the Valley of the Upper Thames would be greatly benefited,

INSTITUTION OF ENGINEERS IN SCOTLAND.

ON A STEREOMETRIC TABLET FOR THE COMPUTATION OF EARTHWORK.

By Mr. John Warner, of Pennsylvania, U.S.

This is an instrument intended to assist the computation of earthwork by the method of transverse ground slopes. The measurements taken on the field are—the length of the work; and, at each end, the centre-height, C H, C T (Fig. 1); and the inclination to the horizon of the surface line, D E, K M, of each cross section. To simplify the explanation, the surface of the ground is assumed to be plane.

Plane Surface.—The problem, then, is to find the solidity of a prismoid included between the end planes, A B K M, A B D E, the side slopes, B D, A E, and the plane surface joining M K, D E. The elements necessary for computation are—the sum of the whole end heights, H N, T N, and the difference of those heights; the slope or inclination to the horizon of K M or D E; also the width of the road bed, A B, and the rate of the side slope; that is, the inclination of B K or A E to the horizon.

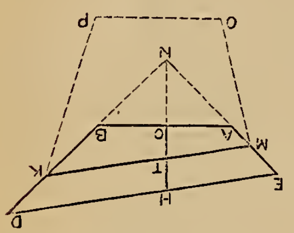


Fig. 1.

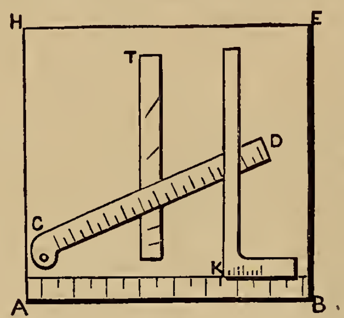


Fig. 2.

Suppose C H = 28·7, C T = 14·5, the slope of K M or D E = 15°, the width of road bed, A B, = 24 ft., the side slope $1\frac{1}{2}$ to 1, and the length of the work 100 ft., we shall then have the sum of H N and T N = 43·2, and their difference = 14·2.*

* These dimensions will be easily found by the reader. In the author's treatise on earthwork, an easy system of obtaining these elements is taught; but it would divert attention from the main subject to enter now on further explanation of this point. See Treatise, Article 59, p. 31:—*New Theorems, Tables, and Diagrams, for the computation of Earthwork: designed for the use of engineers in preliminary and final estimates of students in engineering, and of contractors, and other non-professional computers. Illustrated by original engravings, and a series of lithographic drawings from models, showing all the combinations of solid forms which occur in railroad excavations and embankments.* 8vo. pp. 316. Philadelphia, J. B. Lippincott & Co., 1861.

The Stereometric Tablet is represented in Fig. 2. It consists essentially of a flat tablet, A B E H, with three scales, A B; C D, upon a pivot at C; the scale, T; and and a movable square, K. The back of the square contains a vernier, by aid of which distances can be taken upon A B in feet and tenths.

The scale, A B, is called the radius scale; C D, the secant scale; and T, the tangent scale. Both C D and T require a peculiar graduation, of which we shall hereafter speak particularly. At present it is sufficient to say that C D represents length, and T represents the slope of the ground surface.

The Stereometric Scale, (Fig. 4), is used in conjunction with the tablet. Before proceeding to exemplify the use of the tablet, it would be proper to show the use of this scale. It is employed to find the equivalent sum of heights, that is, the double whole end-height (or twice the height corresponding to T N, Fig. 1) of a prism standing on a triangular base similar to N K M, of the same length as the given prismoid contained between A B K M and A B D E, and having the same solidity.*

* The scale is easily prepared for any given width of road bed and rate of side slope, but we cannot here enter on further explanation of this point. See Treatise, Article 97, p. 48; and Article 12, section 3, p. 301.

To find the equivalent sum of heights by the scale, the method will be best shown by an example. Take the dimensions given in figure 1.

The sum of the end heights is 43·2, and their difference 14·2. On the first side of the scale, marked "sums," take 43·2, and extend the dividers to the difference, 14·2, on the scale of "differences." Keeping the dividers set, go to the second side of the scale, place one point at the mark of the surface slope 15,° as nearly as can be estimated, on the scale of "degrees," and read the number to which the dividers reach on the scale of "depths," say 58 ft.: this is the equivalent sum of heights required.

To find the Solidity by the Tablet.—Take the same example. The scales C D and T of the tablet (Fig. 2) are supposed to be proper for the given side slope, $1\frac{1}{2}$ to 1. We must now go on to the tablet with the equivalent sum of heights, 68, as above found, and with the surface slope 15°.

Set the square, K, to read 68 upon A B, and set the scale, C D, at 15° upon T. We then read upon C D as marked by the blade of the square, say 109·7. With the quantity, 109·7, we enter a suitable table,† where, opposite 109 feet, and under 7-tenths, we find the content of the work, say 5571 yards.

If desirable, questions of the following kind may be resolved by the tablet:—

Suppose O P (Fig. 1) to represent the road bed, and suppose a piece of rock cutting, as O P K M, to begin above by an earth cut, M K D E. How is the computation to be performed?‡

The cross-section of one end of the work only (as the figure now viewed represents) will be sufficient to illustrate the method of proceeding.

Compute, by the tablet, the rock cutting in the manner just described, taking care that the scales, C D and T, are suitable for the side slope of the rock cutting. It then remains to compute the earth cutting, M K D E.

Produce the side slopes, D K, E M, to meet in N, and perform this on each end cross section; then proceed, as before, to find the content res-

† Table XV. of the Treatise. This table contains the eighth-parts of square prisms 100 ft. long. The side of the square base of such a prism, multiplied by $\sqrt{8}$ would give the number 109·7 above used to enter the table. See Article 25, section 5, p. 312. We may, if desired, compute by tablet the whole ground inclosed between the surface and intersection of side-slopes, and then subtract the redundant prism standing. (Article 85, p. 41, and 13, p. 302.)

‡ As a similar question was proposed when the tablet was exhibited, the answer then given may be appropriately repeated here. Compare Article 92, p. 46.

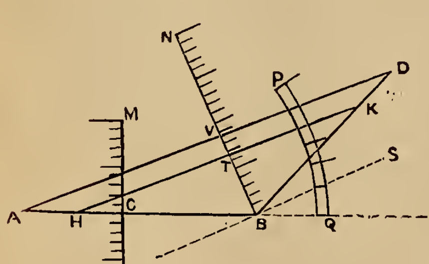
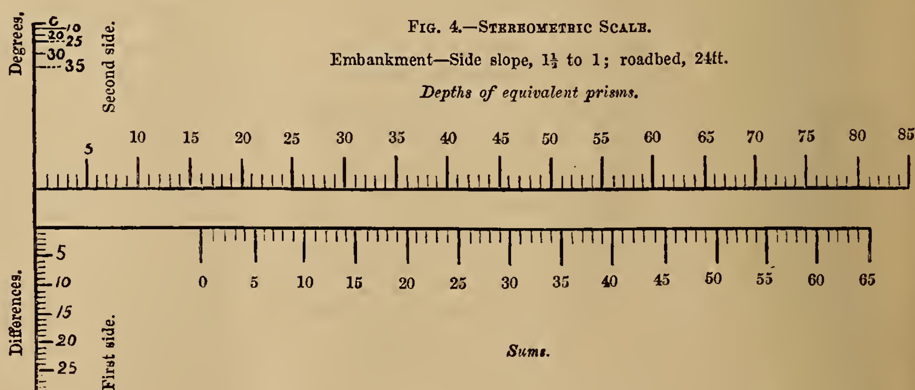


Fig. 3.

Fig. 4.—Stereometric Scale.

Embankment—Side slope, $1\frac{1}{2}$ to 1; roadbed, 24ft.

Depths of equivalent prisms.



Sums.

pectively of the solids on N D E and N K M. The difference of these solids is the earth cutting, K D E M.

Where the end cross sections, if complicated in form, can be reduced to equivalent triangular cross sections, having side slopes to which the tablet applies, an approximate result can generally be obtained. But the writer will not now elaborate this suggestion.

The pyramids, and truncated pyramids, which frequently occur in benching upon hill-sipes, may be computed by the tablet.

Suppose H B K and A B D (Fig. 3) to be the end cross sections of a truncated pyramid. Bisect the side-slope, D B Q, by the line B S, and draw B N perpendicular to B S; B N will then bisect A B D. By drawing a scale of feet on C M at the centre of the road bed, and also on B N, and by appending a graduated arc, P Q, of which the centre may be placed at C, a diagram will be formed on which various cross sections may be drawn in pencil, and erased when no longer needed. The scale C M will be convenient for taking centre-heights, the arc P Q will give the surface slope, and the scale B N will measure new heights, which are to be used in computation by the tablet. It is evident that these new heights, such as B V, correspond entirely with such heights as H N in (Fig. 1); and that if a prism standing on a triangle similar to N D E can be computed from heights similar to H N, so can in Fig. 5, a prism standing on a triangle similar to A B D, be computed from heights similar to B V. It will only be necessary to take care that the scales, C D, and T of the tablet, are adapted to the angle, D B S, as the side slope, and to the angle between A D and B S, as a new surface slope. Let us take an example:—

Example.—Suppose the width of road-bed to be 28ft., that is, B C 14ft.; the centre height of A B D = 4·0, of H B K = 2·1, the surface slope 20°, the side slope 1 to 1, the length of the work 100ft. The line, B V, will be found to measure, say 8·6; B T to measure, say 6·7. The sum and difference of these new heights will be 15·3 and 1·9. Then by scale* we shall find the equivalent sum of heights, say 15·4. Then on the tablet (Fig. 2, the scales C D and T, being adapted to the work), take 15·4 upon A B, set C D at 20°, and read on C D, say 34·0. Then, in Table XV., opposite 34ft. and under 0 tenths, find the content, say 535 yards.

In the case of a pyramid, one of the new heights, as B T, will be nothing; and this value must be used in taking the sum and difference. Then work as before.

If the length of the work differs from 100ft., the solidity as above found is to be taken proportionally according to the real length.

Warped Surface.—We have assumed the surface slope at both ends, (Fig. 1), to be the same, and the surface a plane. If the slope is different at the two ends, or if it is in opposite directions, the surface will be warped. In this case, if a solid can be found with a plane surface, and containing exactly or nearly the same solidity as the work under the warped surface, the content of such a solid can evidently be computed by the tablet. The writer has shown that a good approximation may be obtained, by computing as for a prism standing on the mid cross section of the work.† If desired, this approximation may be corrected by means of a small second term, which can also be found by aid of the tablet.‡ If the computor chooses to assume any particular height and surface slope under plane ground for the base of a prism, he may work by the tablet.

Curves.—It is usual, at least for preliminary estimates, to compute on curves as if for straight work. But when it is judged desirable to take curvature into account, the writer's method is to compute as if for straight work, of the given end dimensions, and 100ft. in length; this may be done by the tablet. The content thus found is then corrected for curvature, after which, if the length differs from 100ft., the corrected content is taken proportional to the length.§

Graduation of the Scales C D and T.—For cross sections, such as Fig. 3, we may take A B on a scale of 20ft. to the inch; then divide 10in. by the square root of twice the rate of side slope. The result will correspond to 10in, on A B—that is, the length thus found will contain 200 parts or feet upon C D. Thus, for the side slope $1\frac{1}{2}$ to 1, twice the rate of slope is 3; then, 10 divided by $\sqrt{2}$ gives 5·7735. This length is divided into 200 parts on C D.‖

To find the mark on the scale, T, which corresponds to any given degree of surface slope, make radius equal to the rate of side slope, draw from the centre a line inclosing with radius an angle equal to the surface slope, and find the natural tangent of this angle for the assumed radius. Then, with radius equal to unity, take the tangent thus found for a sine, and construct the angle corresponding to this sine. This angle is the angle included between A B and C D, upon (Fig. 2), for the given surface slope. The constrnction is simple in practice.*

For pyramids and truncated pyramids, proceed to graduate the scales as before, only taking care to use the half of the angle D B Q—that is, D B S (Fig. 3), to obtain a new rate of side slope; also instead of the real surface slope, D A Q, to use the angle included between D A and B S. The point on the scale T, (Fig. 2) however, which has been thus obtained, must be marked with the degree of the real surface slope, D A Q. Two graduations will arise, one counting up the scale, T, and the other down it; for it will be noticed that when D A Q = S B Q, the *new* surface slope of D A is nothing—that is, the mark is at the bottom of the scale, T. The graduation will begin, on one side of the scale, with the marks for the lower numbers of the real surface slope running down until the real surface slope is equal to S B Q, when the bottom of the scale is reached, and the graduation will proceed upwards on the other half of the scale.

Construction of the Tablet in Practice.—The body of the tablet may be made of wood not liable to warp. The scales, A B and C D, and the square, K, made be made of metal. The scale, C D, adapted to a particular side slope, may be changed for another adapted to another side slope, by simply lifting off and putting over the pivot, C. If desirable, four scales may be engraved on the four edges of C D, and four pivot holes placed at the four corners. The scale, T, for any particular side slope, may be placed upon one of the faces of a polygonal roller let into the tablet. Several such rollers may be made if desired.

An expert draughtsman may, however, prepare his own tablet. A paper scale, A B, can be pasted on the edge of a drawing table. The square, K, may be supplied by a T-square applied to the edge of the table; or the scale, A B, may be pasted on the edge of a flat rule, and a right-angled triangle applied to the rule. The scale, T, may be graduated on paper, when means will readily be devised to fasten this scale, or to exchange it for another when necessary. The scale, T, should have its zero upon a line drawn through through the pivot, C, parallel to A B. The vernier of the square, K, must show zero upon A B when the edge of the blade is at the centre of the pivot, C.

The writer has thus shown that all ordinary problems occurring in the method of transverse slopes can be expeditiously solved by the tablet, with the aid of a single table. If it is considered sufficient for preliminary estimates to assume the ground to be level transversely, the tablet is simplified. It will then only be necessary to keep the scale, C D, permanently set at 0°—that is, to draw the scales, A B and C D, side by side, on the same paper. The square, K, and scale, T, may be dispensed with. Or an instrument may be constructed, by inserting between the scales a movable slide, instead of the square, K. This slide may be set to the proper mark upon A B, when the required distance upon C D can be at once read. If desired, instead of reading the distance on C D and then going into Table XV., the numbers corresponding to the divisions of C D may be extracted from the table, and placed on this scale; the difference for tenth-parts may also be recorded. The instrument may be of sufficient size to permit the requisite numbers to be thus placed.†

Of the Nature of the Ground Surface.—Whether or not it is sufficient for preliminary estimates to assume the surface to be level transversely, will be regarded by some as a matter of opinion, which cannot be decided by the dictum of any one writer. The present writer does not consider this assumption sufficiently accurate. It may at least be said, in favour of taking the ground slope into account, that the labour of measuring the slope is not great, and that estimates which take account of this slope will approximate to the truth considerably nearer than estimates which disregard this element of computation. This may be exemplied in the following manner:—

Let the length be 100ft., the end heights 13ft. and 9ft., the road bed 24ft., the side slope $1\frac{1}{2}$ to 1, the surface slope 9°. The content will be found to be 1777·9 yards. Had we, with these dimensions, assumed the ground to be level transversely, we should have found for the content 1657·4 yards, which is too little by 120·5 yards, or about 7 per cent. The mean height of the given section is 11ft., and the content for this mean height under 9° slope is 1770 yards. Under level ground we should find 1770 yards to correspond to a mean height a little over $11\frac{1}{4}$ft.

Again, suppose a mean height of 5ft. with the other dimensions as before. Under 9° we find the content to be 639·5 yards; this quantity under level ground corresponds to a mean height a little less that $5\frac{4}{10}$ft.; the actual content under level ground for a mean depth of 5ft. is 583·3 yards, which is too little by 56·2 yards, or about 9 per cent. too little.

It therefore appears, that with the not unusual dimensions of these examples, the error of computation is from 7 to 9 per cent., and this error corrresponds to an error of about $\frac{1}{2}$ foot in taking the levels. Such errors in levelling for preliminary estimates would not, the writer thinks, be

* See treatise, Article 96, p. 47, and Article 12, section 2, p. 301. The width of road-bed on the stereometric scale (Fig. 6), is now 0.

† See Treatise, Article 104 p. 52, and Articles 6, 7, 8, pp. 293—294, for the necessary details.

‡ The height and the surface slope of the secondary prism (Article 6, p. 293) may be measured, and the prism computed.

§ See Treatise, Article 105, p. 53.

‖ See Treatise, Article 25, sec. 5, p. 312.

* The Tablet is a mechanical exhibition of diagrams similar to that of Plate XIV. (Treatise). The scale, A B, corresponds to C K; the scale C D to C Φ; the scale, T, to the graduation on the margin of the Plate, and the square, K, to the line K Φ. For further details see Articles 23, 24, 25, pp. 309—313.

† Such an instrument may be seen in the Engineering School of the Glasgow University.

tolerated even by engineers who might consider it sufficient in practice to neglect the transverse slope.* It was asked at the meeting, whether computation by transverse slopes is not going out of use in America. The writer is not aware that this is the case.† The true question to be settled, however, is whether or not this mode of computation ought to be retained. To settle this, we should look rather to the necessity of the case than to indirect proofs founded on a supposed disuse of the method. In the writer's opinion, it is as necessary to attend to the transverse slope in computation, as it is to take into account single tenths of feet in the end heights.‡ It has long been held by American authorities to be necessary, and it is still their practice to take the tenths into account.§

The writer will not here enter into a formal discussion of the most probable hypothesis concerning the form of the ground surface. It is sufficient to express his belief that, at least for preliminary estimates, the computer may use the tablet with advantage, because he can, either according to some hypothesis he may adopt, or by an empirical estimate,|| find centre heights and serface slopes which will give a good approximate result. The facility and expedition in the employment of the tablet will, he thinks make it a valuable instrument, not only to professional engineers, but to contractors and other non-professional computers, who may either desire to test the computations of engineers, or to prepare for duty in a field corps.

RESULTS OF AN EXPERIMENTAL INQUIRY INTO THE COMPARATIVE TENSILE STRENGTH AND OTHER PROPERTIES OF VARIOUS KINDS OF WROUGHT IRON AND STEEL.

By Mr. David Kirkaldy.

Mr. Kirkaldy exhibited several cases of the fractured specimens upon which his experiments were made; and. by way of introduction to the discussion, there were read from his treatise the following conclusions arrived at by Mr. Kirkaldy in the course of his inquiry:—

1. The breaking strain does not indicate the quality, as hitherto assumed.
2. A high breaking strain may be due to the iron being of superior quality, dense, fine, and moderately soft, or simply to its being very hard and unyielding.
3. A low breaking strain may be due to looseness and coarseness in the texture, or to extreme softness, although accompanied by very close and fine quality.
4. The contraction of area at fracture, previously overlooked, forms an essential element in estimating the quality of specimens.
5. The respective merits of various specimens can be correctly ascertained by comparing the breaking strain jointly with the contraction of area.
6. Inferior qualities show a much greater variation in the breaking strain than superior.
7. Greater differences exist between small and large bars in coarse than in fine varieties.
8. The prevailing opinion of a rough bar being stronger than a turned one is erroneous.
9. Rolled bars are slightly hardened by being forged down.
10. The breaking strain and contraction of area of iron plates are greater in the direction in which they are rolled than in a transverse direction.
11. A very slight difference exists between specimens from the centre and specimens from the outside of crank-shafts.
12. The breaking strain and contraction of area are greater in those specimens cut lengthways out of crank-shafts than in those cut crossways.
13. The breaking strain of steel, when taken alone, gives no clue to the real qualities of various kinds of that metal.
14. The contraction of area at fracture of specimens of steel must be ascertained as well as those of iron.
15. The breaking strain, jointly with the contraction of area, affords the means of comparing the peculiarities in various lots of specimens.
16. Some descriptions of steel are found to be very hard, and, consequently, suitable for some purposes; whilst others are extremely soft, and equally suitable for other uses.
17. The breaking strain and contraction of area of puddled-steel plates, as in iron plates, are greater in the direction in which they are rolled; whereas in cast-steel they are less.
18. Iron, when fractured suddenly, presents invariably a crystalline appearance; when fractured slowly, its appearance is invariably fibrous.
19. The appearance may be changed from fibrous to crystalline by merely altering the shape of the specimen so as to render it more liable to snap.
20. The appearance may be changed by varying the treatment so as to render the iron harder and more liable to snap.
21. The appearance may be changed by applying the strain so suddenly as to render the specimen more liable to snap, from having less time to stretch.
22. Iron is less liable to snap the more it is worked and rolled.
23. The skin or outer part of the iron is somewhat harder than the inner part, as shown by appearance of fracture in rough and turned bars.
24. The mixed character of the scrap-iron used in large forgings is proved by the singularly varied appearance of the fractures of specimens cut out of crank-shafts.
25. The texture of various kinds of wrought-iron is beautifully developed by immersion in dilute hydrochloric acid, which, acting on the surrounding impurities, exposes the metallic portion alone for examination.
26. In the fibrous fractures the threads are drawn out, and are viewed externally, whilst in the crystalline fractures the threads are snapped across in clusters, and are viewed internally or sectionally. In the latter cases the fracture of the specimen is always at right angles to the length; in the former it is more or less irregular.
27. Steel invariably presents, when fractured slowly, a silky fibrous appearance; when fractured suddenly, the appearance is invariably granular, in which case also the fracture is always at right angles to the length; when the fracture is fibrous, the angle diverges, always more or less from 90°.
28. The granular appearance presented by steel suddenly fractured is nearly free of lustre, and unlike the brilliant crystalline appearance of iron suddenly fractured; the two combined in the same specimen are shown in iron bolts partly converted into steel.
29. Steel which previously broke with a silky fibrous appearance is changed into granular by being hardened.
30. The little additional time required in testing those specimens whose rate of elongation was noted had no injurious effect in lessening the amount of breaking strain, as imagined by some.
31. The rate of elongation varies not only extremely in different qualities, but also to a considerable extent in specimens of the same brand.
32. The specimems were generally found to stretch equally throughout their length until close upon rupture, when they more or less suddenly drew out, usually at one part only, sometimes at two, and, in a few exceptional cases, at three different places.
33. The ratio of ultimate elongation may be greater in short than in long bars in some descriptions of iron, whilst in others the ratio is not affected by difference in the length.
34. The lateral dimensions of specimens form an important element in comparing either the rate of, or the ultimate, elongations—a circumstance which has been hitherto overlooked.
35. Steel is reduced in strength by being hardened in water, while the strength is vastly increased by its being hardened in oil.
36. The more highly steel is heated (without of course running the risk of being burned) the greater is the increase of strength, on its being plunged into oil.
37. In a highly converted or hard steel, the increase in strength and in hardness is greater than in a less converted or soft steel.
38. Heated steel, by being plunged into oil instead of water, is not only considerably *hardened*, but *toughened* by the treatment.
39. Steel plates hardened in oil and joined together with rivets are fully equal in strength to an unjoined soft plate; or the loss of strength by rivetting is more than counterbalanced by the increase in strength by hardening in oil.
40. Steel rivets fully larger in diameter than those used in rivetting iron plates of the same thickness being found to be greatly too small for rivetting steel plates, the probability is suggested that the proper proportion for iron rivets is not, as generally assumed, a diameter equal to the thickness of the two plates to be joined.
41. The shearing strain of steel rivets is found to be about a fourth less than the tensile strain.
42. Iron bolts, case-hardened, bore a less breaking strain than when wholly iron, owing to the superior tenacity of the small proportion of steel being more than counterbalanced by the greater dutility of the remaining portion of iron.
43. Iron highly heated and suddenly cooled in water is hardened, and the breaking strain, when gradually applied, increased, but at the same time it is rendered more liable to snap.
44. Iron, like steel, is softened, and the breaking strain reduced, by being heated and allowed to cool slowly.
45. Iron subjected to the cold-rolling process has its breaking strain greatly increased by being made extremely hard, and not by being "consolidated," as previously supposed.
46. Specimens cut out of a crank-shaft are improved by additional hammering.
47. The galvanizing or tinning of iron plates produces no sensible effects on plates of the thickness experimented on. The results, however, may be different should the plates be extremely thin.
48. The breaking strain is materially affected by the shape of the specimen. Thus the amount borne was much less when the diameter was uniform for some inches of the length than when confined to a small portion—a peculiarity previously unascertained and not even suspected.
49. It is necessary to know correctly the exact conditions under which any tests are made, before we can equitably compare results obtained from different quarters.

* In these comparisons we may assume a plane surface both for the level and the sloping ground.

† This method is still practised by eminent engineers in that country. Both during the preparation of his work and since its publication, the writer received the testimony of high American authority as to the value of this mode of computation.

‡ Tables VII. and IX. afford the means of comparing, by inspection of the Table the difference in content caused by a change of one-tenth foot in mean height under the same degree of slope, and the difference due to a change of one degree of slope with the same mean height. Such a comparison will, the writer thinks, support the opinion of the text.

§ See Ellwood Morris, C.E., in *Journal of Franklin Institute*, vol. xxv., second series, p. 23. Mr. Morris objected to the Tables of Macneil, not only that they did not extend to tenths of feet in height, but that they were restricted to level ground.

|| Although the writer will not assume the responsibility of recommending empirical processes yet it must be observed that those who, for the sake of expedition, resort to empirical processes, cannot consistently object to the following passage:—Empirical processes here must be compared with other empirical processes for facility and approximate accuracy. A small empirical increase of the equivalent sum of heights, in order to make up for neglecting the differences, would probably lead to closer results than disregarding the surface slope and assuming the ground to be level transversely, although known to be considerably inclined. Such an empirical process would simplify the operation of the stereometric scale. (Compare Article 101, p. 50.)

50. The startling discrepancy between experiments made at the Royal Arsenal, and by the writer, is due to the difference in the shape of the respective specimens, and not to the difference in the two testing machines.

51. In screwed bolts the breaking strain is found to be greater when old dies are used in their formation than when the dies are new, owing to the iron becoming harder by the greater pressure required in forming the screw thread when the dies are old and blunt, than when new and sharp.

52. The strength of screw-bolts is found to be in proportion to their relative areas, there being only a slight difference in favour of the smaller compared with the larger sizes, instead of the very material difference previously imagined.

53. Screwed bolts are not necessarily injured although strained nearly to their breaking point.

54. A great variation consists in the strength of iron bars which have been cut and welded; whilst some bear almost as much as the uncut bar, the strength of others is reduced fully a third.

55. The welding of steel bars, owing to their being so easily burned by slightly over-heating, is a difficult and uncertain operation.

56. Iron is injured by being brought to a white or welding heat if not at the same time hammered or rolled.

57. The breaking strain is considerably less when the strain is applied suddenly instead of gradually, though some have imagined that the reverse is the case.

58. The contraction of area is also less when the strain is suddenly applied.

59. The breaking strain is reduced when the iron is frozen; with the strain gradually applied, the difference between a frozen and unfrozen bolt is lessened, as the iron is warmed by the drawing out of the specimen.

60. The amount of heat developed is considerable when the specimen is suddenly stretched, as shown in the formation of vapour from the melting of the layer of ice on one of the specimens, and also by the surface of others assuming tints of various shades of blue and orange, not only in steel, but also, although in a less marked degree, in iron.

61. The specific gravity is found generally to indicate pretty correctly the quality of specimens.

62. The density of iron is decreased by the process of wire-drawing, and by the similar process of cold-rolling, instead of increased, as previously imagined.

63. The density in some descriptions of iron is also decreased by additional hot-rolling in the ordinary way; in others the density is very slightly increased.

64. The density of iron is decreased by being drawn out under a tensile strain, instead of increased, as believed by some.

65. The most highly converted steel does not, as some may suppose, possess the greatest density.

66. In cast steel the density is much greater than in puddled steel, which is even less than in some of the superior descriptions of wrought-iron.

The breaking strain per square inch of wrought-iron is generally stated to be about twenty-five tons for bars and twenty tons for plates. This corresponds very nearly with the results of the writer's experiments, of which the following table presents a condensed summary:—

	Highest.	Lowest.	Mean.	
	lbs.	lbs.	lbs.	Tons.
188 Bars, rolled....................	68,848	44,584	57,555	= $25\frac{3}{4}$
72 Angle-iron, &c................	63,715	37,909	54,729	= $24\frac{1}{2}$
167 Plates, lengthways	62,544	37,474	50,737	= $21\frac{3}{4}$
160 Plates, crossways	60,756	32,450	46,171	

Although the breaking strain is generally assumed to be about 25 tons for bars and 20 tons for plates, very great difference of opinion exists as to the amount of working strain, or the load which can with safety be applied in actual practice. The latter is variously stated at from a third to a tenth. It will be observed that whilst much discussion has arisen as to the amount of working strain, or the ratio the load should bear to the breaking strain, the important circumstance of the quality of the iron, as influencing the working strain, or the ratio the load should bear to the breaking strain, the important circumstance of the quality of the iron, as influencing the working strain, has been overlooked. The Board of Trade limits the strain to 5 tons, or 11,200lbs. per square inch.

It must be abundantly evident, from the facts which have been produced, that the breaking strain, when taken alone, gives a false impression of, instead of indicating, the real quality of the iron, as the experiments, which have been instituted reveal the somewhat startling fact, that frequently the inferior kinds of iron actually yield a higher result than the superior. The reason of this difference was shown to be due to the fact, that while the one quality retained its original area, only very slightly decreased by the strain, the other was reduced to less than one-half. Now, surely this variation, hitherto unaccountably completely overlooked, is of importance as indicating the relative hardness or softness of the material, and thus, it is submitted, forms an essential element in considering the safe load that can be practically applied in various structures. It must be borne in mind that although the softness of the material has the effect of lessening the amount of the breaking strain, it has the very opposite effect as regards the working strain. This holds good for two reasons: first, the softer the iron the less liable it is to snap; and second, fine or soft iron, being more uniform in quality, can be more depended upon in practice. Hence the load which this description of iron can suspend with safety may approach much more nearly the limit of its breaking strain than can be attempted with the harder or coarser sorts, where a greater margin must necessarily be left.

Special attention is now solicited to the practical use that may be made of the new mode of comparison introduced by the writer, viz: the breaking strain per square inch of the fractured area of the specimen, instead of the breaking strain per square inch of the original area.

As a necessary corollary to what he has just endeavoured to establish, the writer now submits, in addition, that the working strain should be in proportion to the breaking strain per square inch of fractured area, and not to the breaking strain per square inch of original area, as heretofore. He does not presume to say what that ratio should be, but he fully maintains that some kinds of iron experimented on by him will sustain with safety more than double the load that others can suspend, especially in circumstances where the load is unsteady, and the structure exposed to concussions, as in a ship, or to vibratory action, as in a railway bridge.

The writer has not attempted to explain the cause of the mysterious change produced on steel by heating it and plunging it into water, or the no less singular result effected by plunging it, when heated, into oil. Neither has he tried to account for the mysterious change produced by subjecting iron to the processes of cold-rolling or wire-drawing. The explanation offered by some, of this difficult question, that the iron and steel are condensed by the processes to which they are subjected, is completely contradicted by fact, the metal being actually expanded. The aim of the writer being strictly to ascertain facts, and state the conclusions which he considers to be fairly deducible from them, he has not felt himself warranted in attempting to speculate on a subject respecting which so little is yet known.

In conclusion the writer ventures only to express a hope that the experiments on which he has been so long and unremittingly engaged, may not prove wholly unserviceable to practical science and the world at large. The importance of possessing a thorough knowledge of the capabilities and strength of substances on which the lives and property of so many human beings depend, no one will attempt to deny. The only excuse, if indeed excuse it can be called, for employing an inferior description of material in the rearing of structures on the stability of which such momentous issues are involved, is ignorance or misapprehension of its proper quality. The writer has endeavoured, by a plain statement of facts, to furnish some information on a subject which seems until now to have been denied the attention which its paramount importance demands. Were this question fairly taken up and considered, some security might be afforded against the repetition in future of disasters occasioned by its being so often practically ignored. The necessity of using nothing but the very best descriptions of metal where human life or valuable property is at stake may, be trusts, come soon to be more generally recognised than is is at present And an increased demand for the finer varieties may conduce to a generous emulation amongst the manufacturers to improve still further the quality of their productions. Should his labours tend in any, even the smallest degree to diminish the annual sacrifice of life and property occasioned by faulty material and workmanship, he will feel the satisfaction that they have at least not been entirely in vain.

Mr. Kirkaldy exhibited 490 selected specimens, which were contained in five cases, namely—

In Case I.	9 iron bars, showing elongation and lateral contraction.		
	1 iron plate,	do.	do.
	1 steel plate,	do.	do.
In Case II.	42 steel bars, showing fractures and contraction of area.		
	105 iron bars,	do.	do.
In Case III.	36 steel plates,	do.	do.
	60 iron plates,	do.	do.
	24 angle-iron, &c.	do.	do.
In Case IV.	36 iron bars, showing fractures and effects of difference of shape.		
	40 iron bars, showing fractures and effects of difference of treatment.		
	12 steel bars,	do.	do.
	12 iron plates,	do.	do.
	15 iron bars, showing fractures and effects of strains suddenly and gradually applied.		
In Case V.	46 iron bars, showing fractures of screwed bolts.		
	12 iron bars, showing fractures of welded joints.		
	2 steel bars,	do.	do.
	26 iron bars, showing texture as developed by acid.		
	8 iron plates,	do.	do.
	1 iron plate, with surface cold-rolled.		
	4 iron bars, with surface cold-rolled,		

SOCIETY OF ENGINEERS.

ON THE RELATIONS BETWEEN THE SAFE LOAD AND THE ULTIMATE STRENGTH OF IRON.

By Zerah Colburn.

A great number of experiments have been made by many experimenters to ascertain the ultimate resistance of iron to tension and compression, and its strength has thus been determined with perhaps as much precision as is possible in the case of a material presenting almost constant variations of quality. Every engineer is now aware that, as an average result, the tensile strength of good cast iron may be taken as about 8 tons per square inch and its crushing strength as 18 tons. Wrought iron of fair quality will bear not far from 22 tons per square inch in tension, while its crushing strength is variously stated at from 12 or 15

tons per square inch up to $28\frac{1}{2}$ tons, the last named being given by Mr. Mallet as the result of experiments upon large hammered bars which bore but from 23 tons to 24 tons in tension.

When, however, we come to the question of safe working strength, much difference of opinion exists among engineers, the permanent supporting power of iron being variously estimated at from four-tenths down to one-tenth of its breaking strength. Thus when, some fifteen years ago, a royal commission sat to inquire into the application of iron to railway structures, the late Mr. Glynn, in his evidence, recommended that a cast iron bridge should never be loaded beyond one-tenth of its ultimate strength. The late Mr. Stephenson, with several other engineers, thought a ratio of one-sixth sufficient, while the late Mr. Brunel was satisfied with a ratio of from two-fifths to one-third; or, in other words, if a girder would just bear 100 tons of distributed load, he would put from 33 tons to 40 tons upon it, where Mr. Stephenson would allow not more than 17 tons and Mr. Glynn only 10 tons.

Were we now to have another commission entrusted with the same inquiry, it is not unlikely that as great a difference of opinion would be found still existing. For there is no acknowledged natural principle upon which the safe load of iron has yet been determined, and in the absence or oversight of such a principle each engineer must be governed by his own judgment of what is safe and prudent. It is true that the authority of the Board of Trade has been so far exercised in this matter as to have limited engineers, in the design of wrought iron railway bridges, to maximum tensile strains of 5 tons per square inch; and although it is commonly believed that with wrought iron a compressive strain of from 4 tons to $4\frac{1}{2}$ tons corresponds to a tensile strain of 5 tons, the Board of Trade impose the same limit of strain for both the top and bottom chords of a wrought iron girder. The limit of 5 tons per square inch, it is hardly necessary to say, is an entirely arbitrary one, nor is it modified according to the quality of the iron and workmanship in a structure. Thus, in girder bridges, plate iron is used of which the breaking strength is occasionally not more than 18 tons per square inch. In punching the rivet holes, however, and irrespective of the loss of the metal actually punched out, the solid iron remaining between the holes is injured, so much so that, in a series of experiments made many years ago by Mr. Fairbairn, the mean tensile strength of seven specimens was reduced from 52,486lb. per square inch before punching to 41,590lb. per square inch of solid iron left between the holes after punching,—more than 20 per cent. of the strength of the iron being destroyed by punching, a loss distinct from that of the metal actually punched out. Drilled rivet holes, it is satisfactory to know, are now being adopted in the best class of bridge work, but in bridges already erected and containing plates occasionally no stronger than 18 tons per square inch before punching, the loss of strength ascertained by Mr. Fairbairn would diminish this to about $14\frac{1}{2}$ tons for the net section of metal between the rivet holes. On the other hand the best suspension bridge links have a strength of from 26 tons to 28 tons per square inch of section, and yet the Board of Trade inspecting officers would not probably depart from the arbitrary limit of a maximum strain of 5 tons in either case. As far, therefore, as is necessary to meet the requirements of the authorities, good iron and sound workmanship go for little or nothing; and not only does this remark apply to the interference of the Board of Trade, but, in the case of Chelsea Suspension Bridge, the chains of which are believed to have a tensile strength of upwards of 25 tons per square inch, two of the leading members of our profession have declared that structure to be unsafe until it shall have been so strengthened that the greatest load which the heaviest traffic is likely to bring upon it shall not exceed 5 tons per square inch of the sectional area of the chains. The highest authorities, we are justified in supposing, would, at the same time, be satisfied with the same maximum strain in the chords of a plate girder bridge, even if the actual breaking strength of the solid iron between the rivet holes did not, as we have reason to believe it often does not, exceed 15 tons, or three-fifths that of the links of Chelsea Bridge.

From the illustrations given, the elasticity of solids appears to be no more than the range or play of the attractive and repulsive forces of matter, as variably exerted, but within the limits of rupture or crushing. Thus elasticity is the same in kind whether the repulsive or separating force be externally applied, or whether it be that of heat acting between the molecules of the body. If a bar of good wrought iron be stretched to the one-thousandth part of its length, corresponding, say, to a strain of ten tons per square inch, its elasticity will be fully excited or nearly so, and it will not support a much greater strain without taking a permanent set. It is true that, if the same bar of iron, when not under strain, be heated to from 150 to 200 deg. above its normal temperature, it will also elongate by one-thousandth part of its length, and that without injury. But if this elongation take place under a compressive strain, or, if the iron, first raised in temperature by 200 deg. and thereby elongated, be attached to two fixed points, and thus, while cooling, be made to contract under strain, it will be found that an elongation of not far from one-thousandth of the original length of the bar is the most that can be borne without injury, even when that elongation is due to heat alone. But if the iron be first heated sufficiently to soften it, as railway tyres and gun hoops are heated, the particles will be rearranged, and, within certain limits, without injury; but after the metal has once cooled below the temperature at which the particles have the mobility necessary for this re-arrangement, any further contraction around an unyielding object will be attended with permanent, and, there is reason to believe, injurious strain. Even in setting railway tyres, it is believed to be best to put them on cold, and under graduated pressure, and in the case of gun hoops, Captain Blakely and Mr. Mallet, who appear to be entitled to the credit of the modern system of the ringed construction of artillery, have always insisted upon the importance of a definite degree of shrinkage of each ring, so that the consequent strain shall not exceed the elastic limit of the material. Sir William Armstrong has stated that he does not consider any especial accuracy essential in the distribution of the strains imparted by shrinking his gun hoops upon each other, but it may be questioned how far the failures of so many of the Armstrong guns have been due to neglect in this respect.

It would be interesting to know the precise manner in which a separating strain acts upon the molecules of iron, or rather to know the successive positions of the atoms during the application of the strain. We are, however, without any positive knowledge of the positions which the atoms assume in solidification and under subsequent forging, but the multifarious forms in which all atoms visibly crystallise serve to show us that they cannot all be at equal distances from each other throughout the whole body. If they were, the arrangement would be that of cannon balls in a triangular pyramidal pile. Could we visibly represent the atoms, as occupying the angles of an infinite number of equilateral triangles, we should understand that a linear strain acting to separate any two of the atoms would, at the same time, draw a third atom, if not a number of atoms partly between them. And when, from this intrusion, the repulsive force, or heat, always enveloping the intruding atom, had once overpowered the attractive or cohesive force existing between the two atoms thus strained apart, these would, in turn, cohere anew to the atom which had been drawn in between them, and thus we should have a permanent rearrangement of the atoms, or, in other words, a permanent set, with permanent elongation in one direction, and permanent contraction in a plane at right angles thereto. That the atoms are thus drawn into parallel rows of straight lines, in many kinds of iron at least, seems evident from the appearance of fracture, which presents stringy collections of particles forming what is commonly called fibre, although there is great reason for doubting that anything like fibre existed in the iron before it was broken. Mr. Kirkaldy's recent extensive experiments appear to show, as many others have shown, that iron may be made to break short or to break with an appearance of fibre, just according as it is broken with a sudden blow or a gradual pull. Something like fibre may be imparted, on a coarse scale, by repeated rolling or in wire-drawing, but it is more probable that masses of atoms are thus drawn into strings then that any fibre is really imparted to the atomic arrangement itself.

It is commonly held that, within certain limits of strain, iron is perfectly elastic. There are high authorities, however, who maintain that iron takes a permanent set under even very moderate strains. If we are to understand that the set is exceedingly small, this may be true. The late Mr. Hodgkinson, for example, remarked, on the 381st page of his "Experimental Researches," that two cast iron beams took each a permanent set with weights respectively equal to one fifty-seventh and one-eightieth of the breaking weight. In a discussion at the Institution of Civil Engineers, a Mr. Dines mentioned that he had tested upwards of 8000 cast iron girders for the late Thomas Cubitt, and that he found it hardly possible to apply a weight so small as not to produce some permanent set, one-twentieth of the breaking weight producing a perceptible set. In the experiments of the Iron Commission at Portsmouth a bar of annealed wrought iron 50ft. long was said to have taken a perceptible set with a weight of less than $1\frac{1}{4}$ tons per square inch. After this weight had been doubled, however, the set was still only perceptible; and notwithstanding that the elasticity of annealed iron is known to be inferior to that of unannealed bars, the whole set of the 50ft. bar was but the $\frac{1}{250}$ part of one inch, after a strain of $8\frac{1}{3}$ tons per square inch had been borne; and the set was but the $\frac{1}{20}$ of an inch in 50ft. after a strain of 11·9 tons per square inch. Mr. Edwin Clark has experimented on a wrought iron bar 10ft. long and 1in. square. Under a strain of 3 tons per square inch he gives a permanent set of nearly the $\frac{1}{4000}$ part of an inch in 10ft. With 8 tons the permanent set is given as about the $\frac{1}{1280}$ of an inch in 10ft., and it was not until a strain of 13 tons per square inch had been applied that a set of $\frac{1}{32}$in. in 10ft. became apparent. With such exceedingly minute measurements, we may, perhaps, doubt if there was really any permanent set at all, with strains under 9 or 10 tons per square inch. An increase of temperature in the bar of perhaps a single degree, while the measurements were being made, would more than account for some of the reported sets, even under considerable strains. Thus Mr. Edwin Clark gives the permanent set of his bar, after a strain of 8 tons per square inch, as the $\frac{1}{153846}$ part of its length, and this is almost exactly what the extension of the bar would have been had its temperature been raised but a single degree between the observations. Iron is heated in the very act of straining it, and a sudden breaking strain will generally leave the broken ends too hot to be handled. Such a slight apparent extension might also have occurred while the shackles by which the bar was strained were coming to their bearings. But even if such a microscopic permanent set really existed, it is one of which no engineer would take the slightest serious notice as affecting the strength of the bar in which it was observed. With the means of measurement commonly employed by engineers, ordinary wrought iron is seldom permanently stretched until after it has borne strains of upwards of 8 tons per square inch. In seven experiments by Professor Barlow, on wrought iron bars 10ft. long, two of them retained their full elasticity under a strain of 11 tons per square inch, three bars bore 10 tons without injury, while one bore $9\frac{1}{2}$ tons, and another, made from old furnace bars, did not retain its elasticity beyond a strain of $8\frac{1}{4}$ tons per square inch. All the links for Pesth Suspension Bridge, upwards of 5000 in number, and 12ft. long from centre to centre, were tested without permanent set up to 9 tons per square inch, and those of Chelsea Suspension Bridge were tested, without permanent elongation, up to $13\frac{1}{2}$ tons per square inch. Mr. Edwin Clark, from the results of his experiments, considers that the limit of elasticity of wrought iron is 12 tons per square inch, and this appears to have been adopted by him both for bars having a breaking weight of 24 tons and for plates having a breaking weight of 20 tons. Every chain cable purchased by the Admiralty is tested up to 11·46 tons per square inch of the metal in each side of the link, the standard test being 630lbs. for each circular $\frac{1}{8}$in. of the diameter of the iron of which the cable is made, one half of this strain coming upon each side of the link. The iron of which the cables are made does not, as a rule, take any permanent set when strained to this amount, or to say $11\frac{1}{2}$ tons per square inch. Mr. Howard has stated that the best iron begins to stretch permanently under about 10 tons per square inch in 10ft. lengths, although he occasionally tests up to 15 tons or 16 tons per square inch, the breaking weight being from 26 tons to 28 tons. Mr. Mallet, about four years ago, presented to the Institution of Civil

Engineers the results of a valuable series of experiments on wrought iron and puddled steel, from which it appeared that the elastic limit and the breaking strain under tension were, in the case of certain samples, as follows:—

	Elastic limit.		Breaking weight.
Hammered slab or bar, 12in. × 4in.	15·312 tons.	...	24·062 tons.
Hammered bar	14·219 „	...	22·969 „
Rolled slab or bar, 12in. × 4in.	10·937 „	...	22·969 „
Rolled bar	10·937 „	...	22·969 „
Fagotted forged slab, 4ft. × 4ft. × 1ft.	8·750 „	...	18·594 „
Original faggot bars, Horsfall gun	12·031 „	...	21·875 „
Longitudinal cut, forged mass	9·844 „	...	19·688 „
„ „ „	10·937 „	...	17·900 „
Circumferential „	6·562 „	...	16·406 „
„ „ „	5·470 „	...	16·716 „
Transverse „ „	3·281 „	...	6·562 „
Charcoal rolled bar from borings from the Horsfall gun	5·470 „	...	22·321 „

Sir Marc Brunel made a number of experiments on Yorkshire iron, hammered to small dimensions, or from ⅜in. to ½in. square. A very high elastic limit was obtained, as follows:—

Mean of ten bars began to stretch with 22·2 tons per square inch, the mean breaking weight being 30·4 tons per square inch. With ten other bars the mean strain at which they began to stretch was 24·4 tons, the breaking strength being 32·3 tons per square inch. It is to be borne in mind, however, that these bars were reduced by the hammer only at the centre of their length, and that, therefore, the stretching could be observed upon but a very small part of their length. Mr. John A. Roebling, the engineer of the Niagara Suspension Bridge, has made experiments upon bars similarly drawn down to ⅜in. square at the centre, the breaking weight being 33 tons per square inch; these bars bore a strain of 20¼ tons per square inch with visibly stretching, and when no jar was given to the bars they would support the strain for a week. Upon any vibration, however, the bars immediately took a permanent set.

Under strains, however, considerably within the elastic limit, a gradual rearrangement of the particles of the iron commences; and if the strain be continued sufficiently long, permanent set will after a while take place. The late M. Vicat, whose work on limes and mortars is so well known, began as early as 1830 to investigate the effect of continued strains on unannealed iron wire. He applied various strains to similar wires of a known breaking strength, and continued these strains from July, 1830, to October, 1833. One wire was strained to one-fourth its breaking weight, but beyond the elongation which at once took place no additional stretching occurred in thirty-three months. A second wire was strained to one-third of its breaking weight, and in thirty-three months it stretched at the rate of 2⅝ parts in every 1000 parts of its length, this stretching being additional to that which took place as soon as the weight was applied, but which, of itself, was not sufficient to immediately produce any permanent set. Under a strain of one-half of the breaking weight another wire was stretched rather more than 4 parts in every 1000 parts of its length. Under a strain of three-fourths of the breaking weight a fourth wire stretched, in thirty-three months, 6¼ parts in every 1000 parts of its length, and then broke, which circumstance terminated the experiments. M. Vicat's account of them appeared in the 54th volume of the second series of the *Annales de Chimie et Physique.* It is to be regretted that, in place of the constantly recurring experiments upon the breaking strength of iron, and which, as is already beginning to be understood, give us but a very partial knowledge of its available working properties, we have not a larger experimental acquaintance with the continued supporting power of iron, as afforded by experiments similar to M. Vicat's. Mr. Fairbairn, it is true, made an extensive series of experiments between the years 1837 and 1842, to ascertain how long bars of cast iron would support weights equal to about nineteen-twentieths of their breaking weight. By taking care to prevent any vibration in or about the bars, several of them continued, for five years and upwards, to support nearly their full breaking weight. Their deflection steadily increased, however, during the whole time, and Mr. Fairbairn has stated that some of these bars afterwards broke with but one-twentieth of their original breaking weight. As bearing upon the last mentioned circumstance, it may be remarked that M. Vicat, writing in 1833, observed that M. Henri, an engineer serving in Russia, had already shown that iron which had once withstood a great proof strain, often broke some time afterwards under a much less strain. This fact must indeed have been known to practical men even earlier than in 1830.

Now, in employing iron in any structure where it is subjected to strain, we seek to keep within its limit of elasticity. Yet not only have we but a comparatively small number of recorded experiments to show us what this limit is, even under a single and temporary strain, but we have at least the result of M. Vicat's experiments to show us that we cannot depend upon anything like this limit under a long-continued strain. What experimental knowledge we have goes to show that the original elastic limit of iron is greater when hammered than when rolled, but we are unable to count with any degree of certainty upon the ultimate superiority of hammered iron, in this respect, after long-continued strain. As a rule, also—the abundant evidence of which it is not, perhaps, necessary to introduce into the present paper—all harsh, hard, crystalline irons have a higher elastic limit, in proportion to their breaking strength, than soft, ductile, highly fibrous irons, like Swedish bar, for example; that is to say, the harder irons will bear a greater strain before taking a permanent set, although, as we shall presently have occasion to inquire, it may not follow that they are really superior to other irons which are more readily stretched, and which, indeed, may have an even less breaking weight. What information we have goes to show that there is no settled relation between the elastic limit and the breaking weight of iron; the former is much more variable than the latter, and can hardly be expressed at all as an average result, ranging, as it does, from less than one-fourth to more than two-thirds of the breaking weight; or if the elastic limit be taken irrespective of the breaking weight, the instances already cited show that the former varies from 3¼ tons up to 24½ tons per square inch in different qualities of iron, although the range in ordinary bar iron and plate iron is not nearly as great. Now, no engineer, in apportioning the strains in a structure, would think of working up to or near to the breaking strength of iron. His object is to keep within the elastic power of the iron as exerted through a very long series of years. We ought by this time to have hundreds of trustworthy experiments upon this point where there is now one. If the safe working strength of a metal is limited, as it would appear to be, by its measure of permanent perfect elasticity, we may say that we hardly know, even yet, what is the strength of the materials we are constantly dealing with, notwithstanding that not a year passes without some addition to our stock of knowledge of breaking weights.

While we are about considering the permanent injury which iron suffers when strained beyond its elastic limit, it is to be understood that iron may be strained for a short time almost up to the breaking point without in the least diminishing its strength under a breaking weight subsequently applied. Indeed, in gradually applying the breaking strain to any sample of iron, it is clear that it must have borne 10 tons before it is subjected to a strain of 15 tons, and that it must have borne 15 tons before it is strained to 20 tons, and so on. Not only is this the case, but after a bar of iron has been actually broken under a tensile strain, the two broken portions of the bars will almost always require a still higher strain to break them. The weakest spot in the bar will fail first; and although the breaking strain will at the same time permanently stretch the bar throughout its whole length, the iron on each side of the fracture will still have its original breaking strength. Professor Barlow's treatise on the Strength of Materials contains the results of several experiments made at Woolwich Dockyard, as follow:—

A bolt of Solly's patent iron was nicked at one place, and then broken by a strain of 26·7 tons per square inch. One of the pieces was then tried and broke at 29¼ tons. In the next experiment a bar of the same iron was first broken with 23½ tons per square inch, then again with 26½ tons, a third time with 26½ tons, and a fourth time with 25⅔ tons.

Mr. Thomas Lloyd, engineer to the Admiralty, made a like series of experiments a few years ago, on ten bars of SC crown iron, 1⅝in. in diameter, and 4½ft. long. The mean breaking weight at the first breakage was 23·94 tons per square inch. At the second breakage, with pieces 3ft. long, the mean strength was 25·86 tons per square inch. At the third breakage, with pieces 2ft. long, 27·06 tons per square inch, and at the fourth breakage, with 15in. lengths, 29·2 tons per square inch. Mr. Lloyd's experiments have been held to show that iron was actually strengthened by stretching it; or, in other words, that by destroying the cohesion at one point, the cohesion was everywhere else increased. A more obvious explanation is that the bars first broke at the weakest part, then again at the next weakest part, and so on. A variation of from 23·94 tons to 29·2 tons in the strength of the same bar is undoubtedly large, the greater strength being 22 per cent. more than the lesser: a difference which appeared to exist in each of the ten bars tried. It is well known, however, that hardly any two bars of iron have exactly the same strength, and Mr. William Roberts, manager of Messrs. Brown, Lenox, and Co.'s extensive chain cable works at Millwall, has cut a 12ft. bar of iron into 2ft. lengths, and found on testing that there was a difference of strength of 20 per cent. between the strongest and the weakest of these pieces. In the experiments of the Railway Iron Commission upon the extension of cast iron, the strength of Lowmoor cast bars was 7·325 tons per square inch at the first, and 8·152 tons at the second breakage. Blaenavon iron broke with 6·551 tons per square inch at the first, and 6·738 tons at the second breakage. Gartsherrie iron broke with 7·567 tons per square inch at the first, and 8·475 tons at the second breakage. Other cast iron bars of a certain mixture broke with 6·6125 tons per square inch at the first, and 6·777 tons at the second breakage, the latter being at an unsound place. Upon these results the commissioners remarked that "it would appear that iron, repeatedly broken, becomes more tenacious than it was originally. This erroneous conclusion may be obviated by considering that it would be very difficult, if not impracticable, to obtain cast iron bars perfectly sound and 50ft. long. Fracture may be supposed to take place the first time at the largest defect, and subsequently at those smaller, until, finally, none remain." It is not intended, however, in the present paper, to entirely deny that the breaking strength of iron may be actually increased by being stretched when cold; and this point may be left as an open question. That iron is so strengthened derives some probability from the known fact that its strength is greatly increased by being drawn cold into wire, and also by cold rolling. When heated moderately, or to less than a dull red, and then stretched, iron is strengthened throughout. This treatment is known as thermo-tension, and in an extensive course of experiments made about twenty years ago by Professor Walter R. Johnson, for the United States Government, a total gain of nearly 30 per cent. in strength and length, taken together, was estimated to have been obtained with a variety of irons. A bar of iron, having a strength of 60 tons, was heated to upwards of 500 degrees, and then stretched by 6½ per cent. of its length, when it acquired a strength of 72 tons. Captain Blakely has lately proposed the same treatment of iron, and his experiments, it is understood, corroborate those of Professor Johnson. All the links made for the four great pitch chains employed, with the steamship *Great Britain's* engines, for getting up the speed of the screw, were stretched ⅛in. while at a dull red heat.

But from what has been said, it is not to be supposed that iron is not injured by excessive strains, notwithstanding that the metal strained may, when tried immediately afterwards, still retain its full breaking strength. The injury will appear when a subsequent working strain is long continued; and even without waiting for this, it will be found that the strained iron has been deprived of a large part, if not the whole, of its natural elasticity. In a paper of great value, read nearly seven years ago before the Royal Irish Academy, and afterwards published in a quarto volume entitled *On the Physical Conditions involved in the Construction of Artillery,* Mr. Robert Mallet has laid down a useful measur

of the working and ultimate strength of iron. Poncelet had already employed co-efficients which indirectly expressed, not merely the elastic limit and breaking strength of iron, but the range also through which the force acted in each case in reaching these limits. Mr. Mallet has adapted these co-efficients to the English standard of mechanical work, to wit, "foot-pounds," and he represents the structural value of different materials, or of various qualities of the same material, in one case by the product of the elastic load in pounds into half the range in feet or parts of a foot through which it acts, and in the other case by the breaking weight in pounds multiplied also by half the range, in feet or parts of a foot, through which it acts. Mr. Mallet employs Poncelet's co-efficients, as follows:—

Te = foot pounds in reaching elastic limit of tension.
Tr = " " to produce rupture by tension.
$T^1{}_e$ = " " in reaching elastic limit in compression.
$T^1{}_r$ = " " to produce crushing.

One half the weight into the whole extension, or, what is the same thing, the whole weight into half the extension, is adopted because the force gradually applied to break a bar must increase from nothing to the breaking weight. Upon Dr. Hooke's law *ut tensio sic vis*, the weight of a grain will in some minute degree deflect or extend the heaviest bar of iron, and the deflection or extension will increase progressively, with the weight applied, up to rupture. Therefore, if a bar be stretched 1ft. and then broken with a weight of 33,000lb., the work done will be the mean of zero and 33,000lb. into 1ft. or 16,500 foot-pounds. This, as has been said, is the work done in the case of a gradually applied strain. If, however, the weight be applied without impact, but at the same time instantaneously, upon the bar, it will, so long as the limit of elasticity is not exceeded, and supposing the bar to have no inertia, produce twice its former deflection, and, therefore, twice the ultimate strain. For the weight, in falling through the distance of the deflection due to the load at rest, will acquire momentum sufficient to carry it through an additional distance equal to that of the static deflection. This may be best demonstrated experimentally with the aid of a spring balance. If, upon the pan of a balance sufficiently strong to weigh up to 40lb., a weight of 15lb. be placed, and this be then lifted to zero on the scale and there released, it will descend, momentarily, to nearly 30lb. on the scale; and if there were no opposing resistances and the spring had no inertia, it would descend to exactly 30lb. In the actual application of strains in practice a weight is never thus applied, but a consideration of what would occur under such circumstances is sufficient to show how important it is that vibratory action be not overlooked in considering the strains on bridges. It is to be remembered that this action of suddenly applied loads is only manifested in the case of the application of weights, for if the strain be produced by the sudden admission of steam or any other practically imponderable body, no additional deflection will take place beyond that due to the pressure acting statically. If steam pressure acted in the same manner in this respect as a weight, the steam indicator would show nearly or quite double the pressure acting effectively within the cylinder of the engine.

It will not be attempted in the present paper to enter fully into the application of the co-efficients adopted by Mr. Mallett, for there are objections against, as well as reasons in favour of, their application. It is evident that Tr may be the same in two cases, in one of which a high breaking weight is exerted through a very short distance, and in the other of which a low breaking weight produces stretching through a correspondingly greater distance. But this co-efficient does possess a value in taking account of the combined cohesive force and extensibility of iron, instead of the breaking strength alone. As Mr. Mallet justly observes, glass has a high cohesive force, and is nevertheless useless under strain, owing to its brittleness, while caoutchouc has great extensibility or toughness with but slight cohesion. The products, therefore, expressed by the co-efficients in question do not afford a complete notion of the practical value of a given material unless the factors whereby these products are obtained are also given. The elastic limit of iron, however low, is not to be exceeded in practical use, whatever its range of elasticity may be; nor does it appear prudent to work into the neighbourhood of a high elastic limit when the elastic range is known to be small. It is not to be understood that the co-efficients in question are intended to apply otherwise than in comparison of bars of equal length, else it would result that the measure of Te in a bar of 50ft. long was one hundred times greater than that of a bolt 6in. long, and of the same material and sectional area. For the purposes of the engineer a long bolt is not only no stronger than a short one, but as it can be no stronger than its weakest part, it will follow that the average strength of 100 bolts 6in. long is likely to be greater than that of a single bolt of the same diameter and 50ft. long. Every engineer must be aware of the importance of toughness in combination with cohesive strength in iron, but we need much more extensive and accurate information as to the former; and a consideration of Mr. Mallett's coefficient should lead to additional experiments being undertaken. Mr. Kirkaldy, proceeding upon an independent course of inquiry, but with the same object as that pursued by Mr. Mallet, has lately published the results of a most important series of experiments, which are the first upon anything like an extensive scale, to take into account the combined cohesive force and extensibility of iron and steel. Mr. Kirkaldy experimented upon many hundreds of specimens, but he did not ascertain their limit of elasticity. He has given both the original dimensions and cross sectional area, and the dimensions and area after fracture, and he has also given the amount of elongation at fracture, although he did not ascertain the extension at the elastic limit. The reduction of diameter of a bar at the point of fracture serves to give a practical man a good idea of the quality of the iron, but it does not admit of an expression of the mechanical work done in producing fracture, as does the combined breaking weight and linear extension. In tearing a bar in two, also, we have to consider the permanent stretch communicated to all parts of the bar alike, and the additional stretch at and near the point of fracture. That part of the stretching which extends uniformly throughout the whole bar would, we may suppose, be exactly proportional to the length of the bar, while that part of the stretch which takes place close to the point of fracture would, we may also suppose, be a fixed quantity, whatever might be the length of the bar. Mr. Kirkaldy's specimens of iron and steel varied from 2·4in. to 8·2in. only in length, and with these the ultimate elongation at fracture varied from nearly nothing to 27 per cent. of the original length, whereas longer bars would have shown a proportionally less elongation. The samples which hardly elongated at all were of puddled steel ship plates. One sample, which bore 63,098lb. per square inch of the original area, stretched before breaking but the $\frac{1}{20}$th part of an inch in a length of 7·6in., or less than $\frac{7}{10}$ths of 1 per cent. of the length. Adopting Mr. Mallet's coefficient, the structural value of such a material would be almost nothing. In fact, Mr. Kirkaldy found the puddled steel plates throughout to have much less extensibility than cast steel plates, while the former also were of very irregular breaking strength.

Mr. Fairbairn communicated some of the results of an important series of experiments to the British Association at the Manchester meeting, 1861, from which it appeared that a large model of a wrought iron plate girder withstood without injury 1,000,000 applications of a load equal to one-fourth its breaking weight, and afterwards 5175 applications of one-half its breaking weight, when it broke down. The model was then repaired, and 25,900 applications of two-fifths its breaking weight, and afterwards nearly 3,000,000 applications of one-third its breaking weight, were made, it was said, without injury, although neither the deflections nor the permanent set were given. We know that iron alters its form, temporarily, during the application of very moderate strains, the elasticity of good iron being generally observable with strains of 1 ton per square inch; and we know that its form is permanently changed both immediately on exceeding the limit of elasticity, and gradually under strains nearly approaching that limit. There clearly must be a rearrangement of the particles of iron always going on where the strain is great; and as we know that when even a more moderate strain is eased off the iron tends to resume its original form, it appears incontestible that final injury must result under what may appear moderate although irregular loads—say one-third, or even rather less, of the breaking weight. Iron, it is still to be remembered, has not been employed long enough for purposes of construction to enable us to compare its endurance with masonry, of which there are abundant examples still perfect after many hundred years. At the same time it must not be forgotten that while we can never know the absolute strength of a bar of iron without destroying it under strain, neither can we always infer its strength from its deflection, or apparent range of elasticity, for we are not yet secure against flaws or those other faults of molecular structure, which Mr. Mallet so well describes as "planes of weakness." A bar of iron may have a general strength of 22 tons per square inch, except at a single point in its length, where, for an almost inappreciable linear distance, the strength may not exceed 10 tons. If the bar be broken, this fault will be detected, but hardly, if at all, otherwise; for under a strain of even 8 tons or 9 tons, the extension at the precise point of weakness would be so slight as to be quite overlooked in a general observation of the total deflection or extension.

The application of iron to bridges, especially to those of large span, necessarily requires the most careful consideration in apportioning the strains, since every pound of metal not brought into effective action is so much dead weight or useless load—being not only mis-applied of itself, but requiring additional material to support it. In considering the strains upon iron, therefore, reference has been more particularly made in the present paper to its employment in bridges, but in the case of boilers, iron ships, cranes, ordnance, railway bars, warehouse girders and columns, roofs, engine beams, and in many other applications, the most careful distribution of material and adjustment of strains is of very great importance. Iron is, perhaps, more severely strained in steam boilers than in any other structures. In the case of locomotive engines, there is a disposition to employ still larger boilers and to carry still greater pressures. With 50in. boilers, formed of $\frac{7}{16}$in. plates double rivetted, and carrying, as is now not unusual, from 130lb. to 150lb. pressure, there is at the higher limit a circumferential strain of $5\frac{1}{2}$ tons per square inch at the joints and a longitudinal strain of nearly 2 two tons per square inch along the whole length of the boiler: the resulting strain at the joints being nearly six tons per square inch. This strain is constantly maintained with plates ranging from 21 tons to 24 tons in strength, and under all the contingencies of corrosion, incessant vibration, and occasional sudden exaltations of pressure due to the instantaneous production of steam upon overheated tubes or plates. In many cases we have 4ft. boilers with $\frac{3}{8}$in. plates single rivetted and worked at 120lb., corresponding to a strain of at least $6\frac{1}{2}$ tons per square inch at the joints of the boiler when new: the circumferential and longitudinal strains being both taken here into account. Put under this strain when new, many locomotive boilers are worked in all for from ten to twenty years, and often from three to seven years without any internal examination of the plates. It is not remarkable, therefore, that explosions are becoming so frequent.

We may regard with much hope the increasing use of steel in large masses, as produced by Krupp and by Mr. Bessemer, and others whose discoveries have already effected a great economy in the production of that material. Although a departure from the subject of the present paper, it is interesting also to refer to the introduction of phosphorised copper, as now produced by the Birmingham and other coppermasters. It was announced, about three years ago, as a new discovery by Mr. Abel, chemist to the War department, that the addition of from 2 to 4 per cent. of phosphorus to copper greatly increased its density and strength. There is no doubt of the large advantage of this combination, although it was discovered in the last century, and made publicly known sixty years ago. A French chemist, M. Sage, contributed a paper upon this subject to the *Journal de Physique*, and which was translated into the 20th volume of the *Philosophical Magazine*, for 1805. By combining the maximum quantity of phosphorus with copper, the latter acquired the hardness, grain, and colour of steel, and although M. Sage had already kept the compound for fifteen years it had suffered no change from exposure to the air. It was easily turned and took a fine polish. It may yet be found that copper thus treated is the best material for many of the purposes of the mechanical engineer.

REVIEWS AND NOTICES OF NEW BOOKS.

Practical Mechanical Engineering: With an Appendix on the Analysis of Iron and Iron Ores. pp. 241. By FRANCIS CAMPIN, C.E., &c. London: Atchley and Co., 1863.

This work is neither strictly elementary, nor is it of the high scientific and technical class, but is evidently intended for the use of students advanced beyond the ordinary elementary works, but for whom the very abstruse treatises are not suited. There is scarcely a branch of mechanical engineering upon which the author has not touched, though, of necessity, some of the subjects treated in the articles are very much condensed, and, in fact, conciseness appears to have been attempted by the author rather than literary elegance of expression. The most lengthy chapters are devoted to the general arrangement and practical construction of the steam engine in various forms, the various workshop operations being detailed; the machinery required for carrying these out being previously described. In the more theoretical and elementary parts of the work, the "Physical Basis of the Steam Engine," and the "Principles of Mechanical Construction" are examined, a general law for the action of *levers, hydrostatic presses, pulleys, &c.,* being given in place of the numerous rules in use. The modifications of force produced in the steam engine by the varying positions of the crank, etc., is discussed afresh, and the *moment of pressure* on the main shaft is exhibited by means of diagrams of solids, sections of which at any planes give the *moment of pressure* on the main shaft when the crank is in such places, both for oscillating and fixed cylinder engines. In the appendix are described modes of analysing iron and iron ore in great number, collated with great care. The work is illustrated by twenty-eight lithographs and plates of tools, marine, locomotive, traction, and other engines, some of which are very good, especially those of the Grand Junction Pumping Engine. Numerous woodcuts are also interspersed with the letter-press. In conclusion, we recommend a perusal of this treatise to those intending to follow the engineering profession.

A Record of the Progress of Modern Engineering: Comprising Civil, Mechanical, Marine, Hydraulic, Railway, Bridge, and other Engineering Works, with Essays and Reviews. Edited by WILLIAM HUMBER, Assoc. Inst. C.E., and M. Inst. M.E. London, E. and F. N. Spon, 1863.

The large plates illustrating the works which have been selected by the Editor for the first examples of modern engineering progress, are well executed, and the text is devoted to the specifications issued by the engineers, and upon which the tenders for the execution of the works were based. To make the work complete, the price at which the several parts of the works were executed should be given. The details and minor parts of the structures are drawn on too large a scale, but without doubt the Editor will improve upon the first two numbers, as the issue of the series progresses. A useful selection of good examples will give a high character to the *Record of the Progress of Modern Engineering.*

The Management of Steel; including Forging, Hardening, Tempering, Annealing, Shrinking and Expansion; also the Case Hardening of Iron. By GEORGE EDE. Tweedie, 337, Strand. 1863.

A very excellent shilling's worth. We do not know who or what Mr. Ede is, but infer from the author's preface that he is an artizan; but whatever he may be by trade or calling, he is possessed of a good deal of sound practical experience in the management or treatment of steel. Nothing like the present book has been published since Holtzappfel's very expensive book on "Turning," &c.

Pocket Book of Useful Formulæ and Memoranda, for Civil and Me-Engineers. By GUILFORD L. MOLESWORTH, M. Inst. C.E. London: E. and F. N. Spon. 1863.

Mr. Molesworth has done the profession a considerable and lasting service by publishing his very excellent Pocket Book of *Engineering Formulæ.*

What strikes us first is the very convenient size and form of the book adopted by the author; and next, in glancing over its contents, we are pleased to find many really useful things not to be found elsewhere in any engineering pocket book. Mr. Molesworth's treatment of hydraulics and hydro-dynamics, and motive power generally, is excellent. To the latter branch of his subject Mr. Molesworth has evidently devoted considerable attention, and his collection of formulæ will be found most useful. But to stop to detail everything that is good and useful in this book would be nearly equal to reprinting a list of its contents.

The best wishes we can express towards the author and publisher are, that they may speedily sell off the present edition; that (presuming all the corrections have been already made) that they have stereotyped the work; and that the next edition "all sold" may be 50,000. Indeed, we see no good reason why that number may not be sold, if the book is got up in plain style, at half the present price.

NOTICES TO CORRESPONDENTS.

ALPHA.—Yes. We give you the order *in extenso,* which is as follows:—"As one or more vacancies will probably shortly occur in the junior grade of Engineer officers in the dockyards, my Lords deem it highly desirable that these vacancies should be filled by persons of such age and acquirements that they may be expected, after some years' experience, to become well qualified to serve in the higher grades. This cannot be hoped for if persons of advanced age or low qualifications be selected. With this important object in view, my Lords consider that a somewhat similar course should be adopted in making the selections as obtains in respect of the Shipwrights' officers, and of many others in the Civil Service, namely, by competitive examination. It may be expected that comparatively young men thus selected would be stimulated, by a prospect of promotion, zealously to perform the duties first assigned to them, and to qualify themselves, as far as they may be able, subsequently to perform duties of greater importance. You are therefore to call on the captains of the Steam Reserve and the officers of the factories, to report the names of such candidates, under their orders, as they may consider qualified to fill the situation of Assistant-Inspector of Machinery at the factories. It being intended to subject the candidates to an examination at the Royal Naval College, at Portsmouth, to ascertain the extent of their mathematical acquirements, this qualification need not weigh with the officers in making their selection; they should take into consideration the mechanical abilities of the candidates, their experience and knowledge of steam machinery, and other practical qualifications, as well as their character, conduct, and fitness for the office in question, as far as these may be known to the officers from personal knowledge, or can be ascertained from unquestionable testimonials. Together with the list of names, the age of each candidate (*which must be between* 25 *and* 35 *years*), where he was brought up, and where and how he was subsequently employed, should be stated; copies also of such testimonials as the officers consider important are to be forwarded, with any remarks on the several candidates, which, in the opinion of the officers, ought to be known to their Lordships before they make the ultimate selections for appointments.—By command of their Lordships, W. G. ROMAINE."

G.H.—The Water Ram, you refer to, will raise water to the height of 300 feet, or say 30 times the height of the waterfall by which it is worked. It is necessary to state the number of feet fall, which can be obtained at the spring, or brook to work the ram; the perpendicular height from the lower part of the fall to where the water is required to be delivered; the distance horizontally from the spring, or brook, to the house or premises where the water is required, and, if the spring or streams should be small, it is very desirable to ascertain how many gallons it flows per minute. We may add that this society is a very successful and useful institution.

CONDENSEUR PAR SURFACE.—Yes, considerable interest is now being taken by our neighbours on the subject, and we may mention, as an an evidence of this, that the Societé labre d'Emulation du Commerce et de l'Industrie de la Seine Inférienre at Rouen have included in their programme of prizes for 1864, a prize of 300 francs, to the inventor of a surface condenser, the price of which shall not materially exceed that of the ordinary condenser, and the use of which will allow of steam generators being supplied almost exclusively with the distilled water of condensation.

D.L. (permanent way).—The best method we know of is that invented by a Mr. Perry, of Brighton, who employs a *hollow* trenail in conjunction with an iron spike of peculiar shape. The spike being driven into the hollow trenail, which is expanded at its lower end, so as to form a dovetail within the sleeper. The plan is found, in practice, to answer very well, and the trenail is thus prevented from being withdrawn from the sleeper, and the spike, or pin, from being withdrawn out of the trenail.

INGENERO (Milan).—Saxby's system of locking railway points and signals is the most effectual remedy we know of to overcome the difficulty you refer to.

C. B.—For what is known as black malt, the rotary kilns are preferable. But if you require merely to thoroughlydry, or desiccate the grain, and not to *roast* it, we should recommend the employment of an open wire kiln floor, through which, and amongst the kiln charge, currents of heated air are caused to circulate, The apparatus best adapted for this purpose is that known as the Steam Desiccator. Send us further particulars as to the number of quarters, and what power you have at hand, &c.

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

FOWLER'S STEAM PLOUGH.—In the Court of Common Pleas an action has been tried for the infringement of certain patents for steam ploughs. The plaintiff was substantially Mr. John Fowler, of the Steam Plough Works, Leeds, and the defendants were Messrs. J. and F. Howard, the agricultural implement makers, of Bedford. It appears that the original plough was invented, in 1855, by Messrs. D. and T. R. Fiskin, school teachers, in Scotland, and consisted of a new and very peculiar arrangement of the ploughs, and in the mode of lifting them a great stride was made in the progress towards perfection. Subsequently it was thought necessary to find some other means of raising or depressing the ploughs, and accordingly a very ingenious contrivance was adopted by Messrs. Fiskin, consisting of a screw shaft—in other words, an endless screw, which worked upon a cogged wheel, and by turning which around one way the ploughs were raised, and by turning it in another they were depressed. The following year it struck Mr. Fowler that, instead of having separate levers and axles, with the peculiar arrangement in the centre to unite

them, it would be preferable to place all the ploughs in one frame, so that both the sets should move together. This idea he carried out: the ploughs at each end of the frame were fixed, and the frame made to move with a reciprocating, or see-saw motion, on one axis. The mode of bringing this into action is as follows:—The ploughs being drawn by the motive power to the headland, it became necessary to lift one set out of the earth and to put the others in to cut the next furrow; and all that had to be done was to apply the moving force to a chain or rope attached to the bottom of the machine, and as soon as that was effected the tendency of the draught was to drive the plough at that end into the ground, while it pulled out those at the other end. As one set rises the other falls. In the year 1861 it became perfectly manifest to all agricultural implement makers that Fowler's ploughs, following and improved upon Fiskin's, were the very best ploughs that could be devised. It was, therefore, important to all manufacturers of any note that they should possess the privilege of making those ploughs; accordingly the leading gentlemen in the trade, including Messrs. Clayton, Shuttleworth, and Co., Messrs. Ransomes and Sims, Messrs. James and Frederick Howard (the defendants), and Mr. Charles Burrell, all eminent agricultural implement makers, came to an arrangement that they would take licenses for making these ploughs. For this purpose they agreed to pay Mr. Fowler no less a sum than £30,000, besides a considerable royalty upon each plough, for permission to make and sell such ploughs. The arrangements were completed in September, 1861, and Messrs. Howard signed the agreement with the other gentlemen who were parties to it. In two months after, Messrs. Howard refused to carry out the agreement, and had constructed a plough of their own, which combined both Messrs. Fiskin's and Mr. Fowler's inventions. By so doing it was alleged that the defendants had infringed the existing patents. On their behalf it was contended by Sir Fitzroy Kelly that not only was there no resemblance, but the defendants' machine was totally different to the plaintiff's from one end to the other. Moreover, evidence was called to prove that Messrs. Fiskin were not the real inventors of this machine, but that their brother William had invented the most notorious parts of it. William Fiskin was a Presbyterian minister, and as he had not given his consent when the patent was taken out, therefore the patent was invalid. After a five days' trial the jury found a verdict for the plaintiff on all the issues. Lord Chief Justice Erle, who presided at the hearing of the case, declined to decide technical points raised on behalf of the defendants, and the probability is they will be argued hereafter before the full Court.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

The Water of the Thames.—The principal facts indicated by an examination of the water of the Thames, by Henry Letheby, M.B., M.A., during the years 1861 and 1862, are:—1st. That the water in the middle of the river is invariably charged with a larger proportion of dissolved matter than that near to the shore, but the quantity of suspended matter is greatest in the shore water. 2nd. That the proportion of saline matter in the water is greatly influenced by the rainfall and by the temperature of the river; for when the former is less than two inches in the month and the latter is over 60 deg. Fahrenheit the quantity of saline matter quickly rises from the normal proportion of about 32 grains in the gallon to upwards of 100 grains. 3rd. That when, from evaporation and a diminished rainfall, the supply of water to the river is from the ocean, instead of from the land, the mixture of the sea water with the sewage causes an offensive decomposition, which gives an unpleasant odour to the river. 4th. That during strong winds, and at the proportions of the several constituents of the water during the first six months of the year—namely, from January to June. At that time the amount of saline matter ranges from 22 grains to 34 grains in the gallon, and of this quantity about 3·5 grains are organic. In the summer and autumn months, when evaporation from the river is considerable, the quantity of dissolved saline matter in the water sometimes exceeds 150 grains in the gallon. This shows that at those times of the year there is a strong upward current from the ocean, and it indicates the necessity, at those periods, for a very perfect defæcation of the sewage of the metropolis, which is to be discharged into the river at Barking Creek. If this circumstance is disregarded, the condition of the river in after time, when the main drainage scheme is completed, will be unbearable and absolutely dangerous to health. Finally, it may be said that the result of the constant examinations of the river water has been gradually improving, and that the special manufacturing impurities which were once so constantly present in the water are now no longer there. This is attributable to the careful supervision which is exercised by the officers of the Conservancy in preventing the discharge of such matter into the stream.

Coal and Iron in France.—The official documents which have been recently laid before the French Chambers contain the following returns with regard to the production of coal and iron in France, and the importation of British iron. *Coal.*—The production of pig and cast iron in France was, in 1859, 7,500,000 tons; 1860, 8,039,168 tons; 1861, 8,400,000 tons; 1862, 9,400,000 tons. The price of coal at the pit's mouth was, in 1860, 9*s.* 1½*d.* per ton; 1861, 9*s.* 1½*d.* per ton; 1862, 9*s.* 0½*d.* per ton. *Iron.*—The production of pig and cast iron was, in 1862:—Smelted with charcoal, 285,000 tons; value £1,949,200; per ton, £6 16*s.* 6*d.* With coke, or coke and charcoal mixed, 768,000 tons; value, £3,456,000; per ton, £4 10*s.* Total of all qualities in 1862, 1,053,000 tons; value, £5,405,200. The production of pig and cast iron was, in 1861:—Smelted with charcoal, 293,000 tons; with coke, or coke and charcoal mixed, 590,000 tons. Total of all qualities in 1861, 880,000 tons. The total production of all descriptions of pig and cast iron was, in 1859, 856,152 tons; and the total in 1862 having been 1,053,000 tons, it appears that there has been an increase in the total production in France during three years of nearly 25 per cent. The quantity of bar and other descriptions of wrought iron manufactured in France was, in 1862, with charcoal, 71,100 tons; value, £1,194,800; per ton, £16 16*s.* 1*d.* With charcoal and coke mixed, 29,400 tons; value, £404,000; per ton, £13 14*s.* 10*d.* With coal, 600,000 tons; value, £5,724,000; per ton, £9 10*s.* 9*d.* The total of all descriptions of bar and wrought iron manufactured was, therefore, in 1862, 700,500 tons; value, £7,322,800 The quantities manufactured were, in 1861, with charcoal, 76,600 tons; with charcoal and coke, 32,400 tons; with coal, 493,700 tons. The total quantity manufactured in 1861 was, therefore, 602,700 tons. The quantities manufactured were, in 1859, with charcoal, 90,660 tons; with charcoal and coke, 16,930 tons; with coal, 412,510 tons. The total quantity manufactered in 1859 was, therefore, 520,000 tons; and the total manufactured in 1862 having been 700,500 tons, it appears that there has been an increase in the total production in France during three years of 180,500 tons, or more than 33 per cent. The quantities of British iron imported into France during the first 11 months of 1862 were—pig-iron, 149,551 tons; bar-iron and rails, 41,565; plates, sheets, and tin-plates, 2650; all other descriptions, 7023 tons.

Explosion of Gas on Board a Steamer.—The iron screw steam ship *Battalion*, 500 tons, belonging to Mr. W. Laing, of Newcastle, was blown up by gas, while off Plymouth, on the 8th ult. She left Cardiff on the 5th ult., with a cargo of 800 tons of steam coal, and on her passage round encountered some very heavy weather. About half-past five a.m., when eight miles SSW of the Eddystone, the mate, who was in charge of the watch, sent three of the crew to get up a spare sail from out of a store-room that was parted off from the hold by a wooden bulk-head. On the store-room hatch being taken off one of the men went down for the sail, and had an open lamp passed down to him. During the passage, it appears, a large quantity of gas had evolved from the coal, and the hatches being all fastened down in consequence of the bad weather, and no other means of ventilation provided, had accumulated in the hold. Directly the lamp was passed down the gas took fire, and the explosion was the consequence. The whole of the hatchways were blown out fore and aft, and either blown to pieces or blown overboard, considerable damage being done by the scattering of the *debris*. The mate had a very narrow escape from being blown overboard from the bridge and had his face seriously injured, and three men were severely burnt.

NAVAL ENGINEERING.

Trial of the "Royal Oak."—The first of the official trials of this armour-clad war vessel took place at Maplin Sands on the 23rd ult., under somewhat unfavourable circumstances of weather. The engines have been constructed by the firm of Maudslay, Son, and Field, and are nominally of 800 horse-power, but can be worked up to 3000 horse-power, and are the horizontal double piston-rod direct-acting, fitted with the improved gear for tightening the piston-rod bands without stopping the engines. The cylinders are 82in. in diameter, and the length of stroke 4ft. The screw is an improved "Griffiths," the blades being bolted to the "boss" with flanges, instead of being fixed with the key and wooden wedges. The diameter of the screw is 19ft., and its weight rather more than 19 tons; by its improved mode of construction the pitch can be readily varied from 22ft. 6in. to 27ft. 6in. Her draught of water was 23ft. 1in. aft, and 20ft. 7in. forward, with her midship ports 11ft. 2½in. from the water. After steaming well out to the Nore, the engines working at little more than half speed, some experiments were made in turning the circle and stopping and starting the engines. The force of the wind at the time was barely 1, and the sea calm. With the helm hard over to starboard, and four men at the wheel, the circle was made in 5 min. 23 sec., with the rudder at an angle of 21½ deg., and the screw making 52 revolutions per minute. The helm was then put hard aport, and with the rudder at 26½ deg. the circle was made in 5 min. 6 sec., the engines making 54 revolutions per minute, the pitch of the screw on both occasions 27ft. 6in., and diameter 19ft. 6in.; vacuum, 24; load on safety valve, 20lb. The frigate was found to answer her helm remarkably well, and turned the complete circle in little more than twice her own length. Experiments were then made in starting and stopping the engines. From the time of giving the order from the bridge to the engine-room, the engines were stopped dead on two separate occasions in 6½ minutes and 6 minutes respectively. From the order being given from the bridge the steam was shut off and engines started in 7 seconds. On reaching the Maplins it was found that there was too great a haze prevailing to allow of the experimental runs being made with safety, and the trial was therefore postponed.

Trial of the "Racoon."—The screw steam corvette *Racoon*, 22, was taken from Sheerness harbour for her final trial on the 23rd of February last. The *Racoon* carries an armament of two 110lb. Armstrong guns, one 12lb. Armstrong and one 12lb. smooth bore guns for boats, one 12lb. Armstrong fieldpiece, and one 6lb. smooth bore gun for practice at short ranges on the upper deck; 16 8-inch smooth bore, and four 40lb. Armstrong guns on the main deck. The trial was under the superintendence of Capt. T. P. Thompson, of the Sheerness steam reserve, and took place at the measured mile off Maplin Sands. The engines were in charge of Mr. Lawson, chief engineer of the ship. The vessel attained an average speed at full boiler power of 10·1 knots per hour; revolutions of engines, 54 per minute; pressure of steam, 20lb.; vacuum, 25lb.; while at half-boiler power the average speed was 7·279 knots; revolutions of engines, 42. The circle was turned with full boiler power, helm to port, 17 deg., in 5 min. 21 secs.; with half-boiler power, helm to starboard, 23 deg., in 5 min. 59 secs. The engines were stopped when going at full speed in 16 secs. from the time of moving the telegraph; they were started ahead in 35 secs., and astern in 25 secs. from dead stop. The *Racoon* is fitted with trunk engines, 400-horse power, made by Messrs. Ravenhill, Salkeld, and Co., and common screw with corners cut off; pitch, 26ft.; diameter, 16ft.; length of blade, 3ft. During the trial the draught of water was 18ft. 2in. forward and 19ft. 6in. aft. There was an entire absence of hot bearings or priming, and the trial was pronounced highly successful both as regards the machinery and the qualities of the vessel.

The Emerald, 35, screw frigate, made her third experimental screw trial on the 18th ult., at the measured mile in Stokes Bay. The screw tested on this occasion was one with six common shaped blades, fixed at equi-distant intervals on a "Griffiths" boss. The weather was very favourable for the trial, the wind scarcely exceeding a force of 1 from the N.E., and the sea being perfectly smooth. The ship drew 20ft. 9in. forward and 21ft. 10in. aft, and the mean pressure of steam during the six runs made at the mile was 22lb., the vacuum being 25in., the maximum revolutions of the engines being 52, and the minimum 50. The runs were completed as follows: the first run in 4min. 31sec., or at the rate of 13·285 knots per hour; the second run in 6min. 10sec., or 9·729 knots; the third run in 4min. 24sec., or 13·636 knots; the fourth run in 6min., or 10 knots; the fifth run in 4min. 26sec., or 13·533 knots; the sixth run in 6min., or 10 knots. The mean speed of the ship was 11·725 knots. The circles were made in the usual manner as follows:—To Port.—Helm up in 17 seconds, with six men at the wheel, and with one a half turns of the wheel rope, the angle of the rudder being 11 degrees. The half of the circle was completed in four minutes and two seconds, and the full circle in seven minutes and 54 seconds, the revolutions of the engines being 49½. To Starboard.—Helm up in 19 seconds, with six men at the wheel, and with one and a half turns of the wheel rope, the angle of the rudder being in this instance 17 degrees. The half circle was completed in four minutes and four seconds, and the full circle in seven minutes and 56 seconds, the revolutions of the engines being 50. The six-bladed screw, as had been anticipated from the results of the Shannon's trials, gave a speed superior to that obtained from the common two-bladed screw by about two-tenths of a knot, with a

rather less indicated horse-power of engine, and a total absence of vibration from the working of the screw, the only motion felt on board being from the movement of the engines.

THE "HECTOR," 32 gun iron frigate, arrived at Spithead on the 15th ult. from the Clyde. The hull, engines, and iron lower masts have all been constructed by Messrs. Napier. The hull is on the principle of the *Warrior* and other iron ships, with the exception that the *Hector* has a heavy bulkhead, or "shield," covered with 4½in. armour plates, fixed across her hows from her lower deck to a level with her bulwarks. This is of semicircular form and is intended to receive the fire of a fort, or that of an enemy's broadside of guns, when using the *Hector* as a ram. Her armour-plating is also continued, from the point at which the *Warrior* now carries her armour-plating, as a helt round her line of gun ports, bow and stern, with additional plating over her outer stern-post and rudder-head. The majority of her armour-plates are rolled, and are from the manufactories of Messrs. Brown, Sheffield; Messrs. Beall, Parkgate, and Messrs. Rigley, Parkhead. The engines have cylinders of 82in. diameter and a stroke of 4ft. The screw is a "Griffiths" of 20ft. diameter and 20ft. 6in. pitch. At the back of each cylinder is fitted a small auxiliary engine for starting and stopping the engines, in addition to the ordinary wheel and hand gear, and all is so simply and efficiently arranged that two men, one at each auxiliary, have perfect control over the engines, the action at the same time heing almost instantaneous. The castings are excellent, and every part is massive, well finished, and simple in arrangement. The screw alley is unusually lofty and roomy, and the disconnecting and other arrangements of the shafting have heen fitted with great care and strength. The stokehole has six boilers—three on each side. The highest temperature reached here during the voyage round from Greenock was 85 degrees. The means of ventilation appear to be very good, although no patented plans have heen applied. The funnel casing is well open on the upper deck, and a square shaft, fitted to hoist out ashes, no doubt contributes in the main to this excellent result, the former acting as an up and the latter as a downcast air-shaft. Above the boilers is fixed a small auxiliary engine, which hoists out the ashes from the stokhole. An auxiliary engine of 40 horse power is also heing fitted on board to work the fire-engines, capstans, &c.

NAVAL APPOINTMENTS.—The following appointments have taken place since our last:—J. Knight, Acting First-class Assist. Engineer, to the *Cumberland*, for the *Erne*; A. G. Smith and J. O. Wilson, Acting Second-class Assist. Engineers, to the *Fisgard*, as Supernumeraries; H. Mackavoy, Acting Second-class Assist. Engineer, to the *Cumberland*, as Supernumerary; M. O. C. M'Cartie and Thomas Barnes, Acting Second-class Assist. Engineers to the *Indus*, as Supernumeraries; J. Mercer, Acting Second-class Assist. Engineer, to the *Asia*, for the *Curaçoa*; J. C. Thompson, Acting Second-class Assist. Engineer, to the *Asia*, as Supernumerary; J. Cleland, J. Prebble, J. A. Cowper, and P. Samson, Assist. Engineers, to the *Indus*, as Supernumeraries; E. Rivers and R. Allen, Chief Engineers, to the *Asia*, for the *Melpomene* and *Imperieuse* respectively, when they are paid off; J. Crew, W. J. Wise, T. E. Williams, T. B. Jordan, H. Rawlings, and F. Earnshaw, Assist. Engineers, to the *Rattlesnake*, on the coast of Africa, as Supernumeraries; G. Lynch, Supernumerary in the *Fisgard*, promoted to Engineer; C. Deal, of the *Rattler*, G. M'Leod, of the *Megæra*, E. R. Cockrell, J. M. Page, and L. M. Green, of the *Asia*, W. Russell, of the *Indus*, J. E. Turner, in the *Black Prince*, and J. J. Finch, of the *Industry*, First-class Assist. Engineers, promoted to Engineers; J. Beech, of the *Greyhound*, W. P. Dawe, of the *Liffey*, and J. Peach, of the *Centaur*, promoted to Acting First-class Assist. Engineers; W. C. Beck, engineer to the *Indus*, as Supernumerary; A. Smart, Assist. Engineer, to the *Cumberland*, for the *Snipe*; P. Thompson, Assist. Engineer to the *Pembroke*; T. Duncanson, Chief Engineer, to the *Orpheus*, for disposal; O. A. Davies, Engineer, to the *Pandora*; S. Lawton, T. Murray, and J. Stirling, Assist. Engineers to the *Sparrow*; E. Newman, Assist. Engineer, to the *Indus*, for the *Clinker*; J. Staley and J. Grant, Assist. Engineers, to the *Pandora*; J. West, Assist. Engineer, to the *Cumberland*, as Supernumerary; S. Madden, Chief Engineer, to the *Indus*, for the *Ocean*; J. Steil, Chief Engineer, to the *Indus*, for the *Pelorus*; C. Dickson, Chief Engineer, to the *Asia*, for the *Hector*; J. Turner, Assist. Engineer, to the *Asia*, for the *Hector*.

TRIAL TRIP OF THE "VIGILANT."—The screw steam gun vessel *Vigilant*, 200 horse-power, which, since her accident on the Gunfleet Sands, has received thorough repairs, underwent her final trial trip on the 2nd ult., at the measured mile, off Maplin Sands. She attained an average speed, at full boiler power, of 10·191 knots; and, at half boiler power, of 7·987 knots, everything working most satisfactorily.

MILITARY ENGINEERING

EXPERIMENTS AT SHOEBURYNESS.—On the 3rd ult. some interesting experiments in gunnery were undertaken on the practice-ground, with the view of testing the resistance offered by Captain Inglis's shield—a most massive and ponderous kind of armour, proposed by that officer as a covering for the exposed portions of fortifications, and generally for casemated batteries facing the sea. Captain Inglis's shield, or rather target, for it is in appearance like any other iron target, with an embrasure in the centre, is as simple in its plan of construction as can well be conceived, consisting of nothing more than very massive double slabs of wrought iron placed transversely. The slabs on the left-side of the embrasure are eight inches and five inches thick respectively, and those on the right seven inches and five inches,—the different thicknesses heing purposely adopted to ascertain if possible their relative powers of resistance. These great slabs are bolted on to the iron backing with most massive screw bolts, and the entire mass supported by time of the equinoxes, the quantity of suspended matter in the water is greatly increased. Lastly, it may be said that the normal composition of the river water is indicated by the wrought-iron struts. The whole principle of the target apparently, consists in meeting the impact of the shot with masses of iron of such strength and solidity as, when properly made and fitted together, would be virtually indestructible by any battery a ship could direct against it. It is also claimed for this invention, or rather combination of slabs, that it is the cheapest as well as the most efficient way that has yet been tried of covering casemates with armour. For the guns used against it the target was much too strong, and its immense thickness prevented any real estimate being formed of the effect of the shots. It had, however, been to some extent injured and shaken by previous trials, and there is no doubt that the seven shots fired at it at short range and all near the same spot was a more severe trial than it would ever be likely to undergo if forming part of a real series of such batteries actually engaging a fleet of iron-clads; yet in spite of this it stood well, and at the close of the day still remained a formidable defence, though, of course, much hent in parts, with bolts displaced, and, generally speaking, damaged. The first experiment was made with Mr. Whitworth's 7-inch muzzle-loading rifled gun, weighing 7½ tons, and nominally throwing a 120-pounder shot, though in reality made for projectiles of the weight at 150lb. and upwards. This was loaded with 25lb. of powder and a flat-headed hardened projectile, weighing 137lb. It struck on the left or 13-inch side of the target with terrific force, emitting at the moment of contact a sheet of flame as broad and vivid as if another cannon had been fired from the mark in reply. The result, however, proved to ho very difficult to ascertain, inasmuch as the head of the shot had quite buried itself in the metal, and what had not penetrated had been shivered to atoms by the tremendous force of the concussion, so that it was quite impossible to say how far it had really gone. Opinions on the subject of its depth varied from 2½ to 7in., but they were all founded on the purest conjecture, and not the slightest impression or disturbance of any kind appeared at the back of the plates to warrant the opinion that it had entered further at most than 4in. or 5in. The velocity at which this projectile struck the target was at the rate of 1240ft. a second. The practice was resumed at the same range and target with Sir William Armstrong's smooth-bored 100-pounder muzzle-loader. The usual service charge of a piece of this kind would be 33lb. of powder, but on this occasion it was loaded with only 25lb., in order to place it on an equality with the Whitworth previously fired. The shot was a spherical wrought-iron 100 pounder, which was made to fit the bore so closely that doubts were expressed whether it would be easy to get it down at all when the gun was fouled after a few rounds of rapid firing. This missile struck full upon the thick side of the target with a velocity of 1470ft. per second, inflicting a tremendous circular dent 2½in. deep, cracking one of the inner plates of the target and knocking off one of the massive holt-heads. The target was roughly shaken, but, for all practical purposes, was as strong as ever, and, to illustrate the facility with which it could be repaired, a fresh bolt and bolt-head were adjusted in place of those broken in the course of a few minutes. The third shot was fired from Sir William's great 300-pounder muzzel-loading gun rifled on his peculiar shunt principle. This tremendous piece of ordnance weighs no less than 11¾ tons. It is rifled with 10 deep grooves on the shunt principle—that is to say that though the shot enters loosely and easily hy the muzzle down one series of grooves, it is regularly shunted into another series, along which it comes out when the gun is fired, and the grooves for exit being shallower than those for entrance, they, as it were, squeeze the shot with sufficient force to make it take the form of rifling, and give it the rotation on its axis so necessary for long range ordnance. This was loaded with a hollow headed conical-shaped shot, 19¾in. in length, and weighing 230lb., and with a 45lb. charge of powder hehind it. It sent the shot with a velocity of 1,405ft. per second full on the thick part of the target, inflicting a broad damaging indent, shaking the whole structure a good deal, and cracking an outer upper plate. But except the mischief that actually showed itself on the surface it was impossible to say with any certainty how much the hutt was really injured. It was in fact much too thick to enable anything but conjectures to he formed as to the comparative results of all the different missiles. The next gun was one of Mr. Lynall Thomas's, a 7-inch muzzle-loading piece, rifled on a very peculiar principle, and capable of throwing projectiles of 150lb., or even 200lb. weight, with charges of powder as low as 25lb. The gun, which is 11ft. 6in. long, is rifled on a new plan of Mr. Thomas's, somewhat in appearance like the *canon rayé* of the French, but with this difference, that instead of three grooves it has three ridges projecting nearly an inch into the hore, the elongated projectiles, which are 2½ diameters long, fitting into and between the ridges. The shot fired was a wrought-iron one of 151lb. weight, with a charge of 25lh. of powder. It was the first time the gun had ever heen fired, and it hit the white spot aimed at so truly as quite to obliterate the mark, doubling up the shot itself into the form of a huge cauliflower, and making an indent almost as severe as that of the 100-pounder smooth hore. The target seemed shaken, though not materially so, the shot having only struck at a velocity of 1215ft. per second. Mr. Whitworth's gun was then again fired at the same range, and with the same charge of powder and shot. The shot was aimed at the untouched plate, below the embrasure, and so close to the ground that the projectile struck the earth first, making a deep furrow; and, of course, considerably diminishing the force of its blow. For this reason it made hut a very slight impression, and did no injury to the target that was worth speaking of. The 300-pounder Armstrong was then tried with a solid shot weighing 306lbs., and a 45lb. charge of powder. This tremendous missile injured the target considerably, and sent its fragments of cast-iron flying through the air in all directions with a hoarse roar that was terrible to hear. The force of this terrific blow broke some of the plates in fresh places, knocked the head off one of the bolts, and drove out another like a rocket. Mr. Lynall Thomas's gun was the next competitor. At the first fire it had recoiled considerably, and thrown its muzzle high into the air, almost at an angle of 45 degrees, and there is no doubt hut that this first discharge injured it fatally, though not in such a manner as could be seen externally. This time it was loaded with 27½lb. of powder, but, instead of wrought iron shot of 151lb., with a steel projectile weighing 133lb. It was fired as usual by electricity, and instantly the whole gun burst into fragments like a gigantic shell. The explosion was so complete and total that the massses were scattered in every direction; one piece weighing nearly a ton being thrown to a distance of 140 yards. Out of the seven shots, too, the last, from Mr. Thomas's gun, can scarcely be reckoned, as, if it ever touched the target at all, which is most improbable, it touched it so lightly as to leave no mark whatever, and of the six shots that did strike, one from Mr. Whitworth's gun grazed the ground, as we have said. Still the victory was with the target. Some most important experiments against floating targets, at 1200 yards' range, against iron embrasures for casemated batteries, and against targets built of unusual size and of the strength of our improved Warriors, will be undertaken this summer at Shoeburyness.

THE RESUMED EXPERIMENTS AT SHOEBURYNESS, which took place on the 17th ult., were arranged to elucidate as much as possible both points in dispute, the guns used being the old smooth-bore 68-pounder, Sir William Armstrong's 110-pounder service gun, with special steel shot cut down at the base to reduce them to 65lb. weight, Sir William's 300-pounder muzzle-loading rifled shunt gun, Mr. Whitworth's muzzle-loading 150-pounder or 7-inch gun, and Mr. Lynall Thomas's 9-inch or 300-pounder rifled muzzle-loading gun. Both these latter were made by Colonel Anderson, at Woolwich, on the built-up coil principle adopted by Sir William Armstrong, and both were admirable specimens of workmanship, though before the experiments commenced, Mr. Whitworth's gun was found to have a crack or flaw in the centre steel tube round which the coils of wrought iron are wound and welded in the course of manufacture. This defect prevented its being used in the course of the experiments except for one discharge with a live shell. Mr. Thomas's gun was an enormous piece of ordnance, nearly 18ft. long, weighing 16 tons, and with a thickness of 17in. of metal round the powder chamber at the breech. Though nominally a 300-pounder, this gun is claimed to be capable of throwing projectiles of various forms and weights from 250lb. up to 400lb. Sir William's 300-pounder weighs less than 12 tons, and was the same short, powerful piece we have already described in our account of previous trials on this ground. The three plates against which this ponderous array of ordnance was directed, at a distance of 200 yards, were bolted up into a target about 12ft. square, the upper plate being 5½in. thick, the middle one 7½in., and the lower plate 6½in. On the right side these plates were backed with 10in. thick of solid teak, behind which again, as representing the skin of an armour ship, were plates of iron, one of 1in. thick and one of 1½in. thick, which rested on the usual upright ribs of wrought iron. The other half of the target was fastened to the iron ribs, but had no teak backing or inner iron skin. The armour plates were made and rolled by Mr. Brown, of Sheffield, and, as the result proved, were beyond all doubt the finest specimens of plates, whether rolled or hammered, which have ever been tested at Shoeburyness. Colonel Taylor conducted the experiments, the arrangements for firing, &c., as usual, being under the care of Captain Alderson. The first shots, three in number, were fired from the old smooth-bore 68-pounder with the usual service charge of 16lb. of powder. These were directed against the 5½, 6½, and 7½-inch plates, and were immediately followed by three shots from Sir William's 110-pounder, loaded with special steel projectiles, weighing 65½lb., and fired with the same service charge as the smooth-bore 68. The result of this experiment proved the inutility, not to say folly, of having comparative trials of rifled guns at so short a range as 200 yards. Where the 68-pounders had struck, the indentation varied from 2½in. to 3in. in depth; where the steel shot of Armstrong's had hit, the mark was in one case deeper, and the plate showed a just perceptible crack about 8in. long, though apparently of very trifling depth. The most careful examination failed to discover any mark on the back of the target, even as much as a disturbance of the paint upon the rivets to show that it had been hit at all. The next shot was fired from Sir William's 300-pounder, loaded with a conical steel shot of 296lb. weight, and fired with 45lb. of powder. This tremendous missile struck with a velocity of 1298 feet per second full upon the centre of the 7½in. plate, where it was backed,

driving in a circular piece of iron 10in. in diameter quite through the plate, bending in the whole plate itself to a depth of 1½in., and buckling its ends outwards more than 1in. The massive wrought iron girder which crosses the whole back of the target horizontally was bent out and broken in several places, as were also the inner ribs, the 2½in. skin was bulged and cracked, the rivet heads loosened, and many knocked off altogether. The examination showed that the target, as a target, had received a most serious shake, though, from the wonderfully good quality of the iron, there was little of actual fracture or cracking except in the spot on which the shot itself had struck, where the whole 7½in. piece was driven in, and only held in place apparently by the wooden backing. The next shot was from the 300-pounder, loaded with a cast iron shell weighing 286lbs., and charged with 11lbs. of powder. This was fired with the usual 45lb. charge, and struck full in the centre of the 5½in. backed plate with a velocity of 1330ft. per second. It shattered its way completely through it, leaving a rough round hole about 10in. in diameter, and then burst in the inside, blowing the teak to minute fragments, setting it on fire, breaking off many of the rivet heads, and tearing the inner skins of iron, 2½in. thick, into rough shredded gaps, as if they had been so much cardboard. Altogether, this shell, both for penetration and awfully destructive effects on bursting, was the most successful that has yet been fired against armour-plates of any kind. Mr. Whitworth's 150-pounder was next tried, loaded with a steel flat-headed shell of 151lb. weight, with a bursting charge of 6lb. of powder, fired from the gun with 25lb. of powder. This shell struck within about 5in. of the spot where Sir William's had struck and burst, and destroyed the teak backing. The Whitworth shell passed quite through the plate, and burst among the *debris* of splinters behind. Apparently, most of its charge must have escaped from the front of the target. Certainly the explosion made not the least perceptible addition to the damage already inflicted by Sir William, nor did it even set the timber on fire, though from the smoke that hung about it was at the moment thought it had done so. From the flaw in the breech of the gun already mentioned, no further trials were made with this piece, and Mr. Lynall Thomas's gun was the next competitor. Unfortunately, from some mistake, the gun was not well pointed, and its first 330lb. shot missed the target altogether, and struck the ground on the left, passing through a bank of earth, and then flying off to the right upwards into the air over the river. The next shot, weighing 307lbs., and fired with a 50lb. charge of powder, struck the hollow part of the target, where it was 7½in. thick, and what is termed "dished it," or bent the plate; but, as was remarked upon the ground, for a projectile of such weight, propelled by such a charge of powder, it effected no commensurate damage. The third shot was more successful. It was a steel projectile of 330lbs. weight, fired with the some charge. It struck on the edge of the 7½in. plate—its weakest part—and made a broken indentation to the depth of 10½in. The terminal velocities of both these last shots were lower than any fired, which was attributed to what is believed to be the excessive pitch in the mode of ribbed rifling adopted by Mr. Thomas. The whole effect of this piece, considering its great length of barrel and force of charge, did not realise the expectations formed of its capabilities in the morning. Sir William Armstrong then fired his 300-pounder with an ordinary cast-iron round shot, weighing 144lb., with a charge of 45lb. The terminal velocity with which this struck the 7½-inch plate on the unbacked portion was the highest attained—no less than 1636ft. a second—and almost in exact proportion to its velocity was the damage it inflicted. Not only was its indent larger and deeper than any shot that had gone before, but on the inner side it broke the plate both vertically and horizontally, leaving a cruciform tear nearly two inches wide at the openings, besides shaking the target to its very foundations. This shot and the steel projectile of Mr. Thomas had, in fact, so damaged the whole of the massive structure, both in its plates and fastenings, that further experiments became almost useless. The iron, even where most torn, held together in a manner that was really wonderful, but Mr. Thomas had knocked off several of the massive screw bolt heads, and the effect af the entire day's work had been to so bend the plates and destroy the backing that there was really no part left that afforded the means of a fair test of resistance, while it was evident that a few more shots like the last might bring the whole mass to the ground. The firing, therefore, was discontinued.

Armour Plate Testing at Portsmouth.—The firing at the sample and experimental armour plates on the sides of the *Powerful*, target ship, at Portsmouth, was brought to a close on the 25th February last, after three days' practice. The firing at the sample plates resulted in nothing of particular interest to the general public or calling for any remark further than that the plate supplied by Messrs. John Brown and Co., of the Atlas Steel Works, Sheffield, undoubtedly carried off all the honours. The firing at the experimental plates proved interesting and important as far as related to the testing of the two bent plates. The crossed planks of iron had been tested in somewhat different forms, but on the same principle, on several former occasions, and have utterly failed in resisting the blows of the 68-pounder. The crossed planks or plates of iron fired at on the present occasion were each 6ft. long by 1ft. wide and 2½in. thick. Six of these were bolted on the *Powerful's* side by side in a horizontal position, the remaining six being laid over them in a contrary or vertical position, and the whole 12 thus covering a 6ft. square space. The supposed object of the Admiralty in making this experiment was to ascertain whether any difference existed, and if so, to what extent, in the shot-resisting qualities of plates bent hot and cold, the latter being the cheaper and more expeditious method. For this purpose one of the 4½in. "Royal Alfred plates" was selected from the stock in store in Portsmouth dockyard, and divided into two parts, each being then about 7½ft. long by 3ft. 6in. wide. It had been intended to bend each of these portions of the plate to a curve of 4½in. from a centre line, but in bending the one part cold in the hydraulic press the metal began to open on the outer curve when the curve had only reached 1½in. out of the intended 4½. Under these circumstances the plate was only bent further to 2¼in., just half the extent originally intended. The other part was bent hot in the wedge press to the same extent, but exhibited no opening of the metal, and was apparently as sound as when first sent in from the contractors. The plates were of rolled manufacture, and had been bent across the grain. The first shot at that part of the plate bent cold decided its fate, the effects produced by the shot proving incontestibly that the very operation of bending the metal cold had completely altered the structure and nature of the metal, rendering it to a great extent crystalline and brittle. The firing at the hot bent plate was attended with as much interest. That bent cold, from the openings exhibited in its bending, was not expected to stand very severe hammering, although the way in which it broke up astonished every one. The hot bent portion, however, represented the sides of our present armoured ships afloat and building. This plate stood but little better than the one bent cold in the hydraulic press, and its structure was also apparently as much changed as that of the cold bent plate by the bending process to which it had been subjected. It may here be stated that the plate selected for this experiment was from the manufactory of one of the best of our armour-plate makers, Mr. John Brown, of Sheffield. With, therefore, this utter destruction by the process of "bending" of all the rigidity and blow-resisting powers of an acknowledged superior description of armour plate, certainly more complete in the "cold" than "hot" process, abundant material is furnished for future and most serious consideration in armouring our ships of war.

Armour-Plate Experiments were resumed at Portsmouth on the 9th ult., under the superintendence of Capt. R. S. Hewlett, C.B. The plates tested on this occasion comprised three of 4½in. in thickness of metal from the Elswick Company—two of iron and one of steel, all three made under the steam hammer, but with the additional novelty attending the steel plate, that after its manufacture it had been re-heated to an annealing heat, and then cooled in oil. There were also two hammered plates of 5½in. thickness of metal, from the Thames Ironworks and Shipbuilding Company, one of which was a sample plate for the *Minotaur* iron frigate, building for the Government by the company, and the other was a plate for the *Royal Sovereign's* turrets, bent 2½in. out of a straight line, when heated, by the wedge-press process. The Elswick plates failed utterly in offering resistance to the shot from the 68-pounder gun, one iron plate being destroyed by a single shot, the other by two shots, and the steel plate being broken up in five separate pieces by two shots. The diameter, depth, and general character of the indents from the shot on the two iron plates, were of the ordinary description, but those on the steel plate were considerably less than what is made by the shot on iron plates, the diameter of the indents in this case being only 6in., and their depth only 1 1-10in. The plate possessed all the required hardness, but also the fatal fault of brittleness. It was made from the best Sheffield steel. The two plates from the Thames Ironworks proved to be of an unusually excellent quality, considerably above the average of good "A 2" plates. It is a remarkable fact in connexion with the cast plate for the *Royal Sovereign*, that there were no cracks or openings in the metal after it was bent, and even when the plate was broken eventually across its back, in a known weak part of the forging, by the severe pounding which it received, the metal did not open with the curve, but across it. This plate received five shots in an irregular triangular space, 1ft. by 1ft. 3in. and 10in. Three of these shots struck in a space of 8in., measuring from centre to centre of the extreme indents. There was no penetration of the plate in any part by the shot, nor was any part of the metal detached from the main body. The other plate, made by the Thames Company for the *Minotaur*, received seven shots in a space of 2ft. 6in. by 2ft., and three of these were on the lower left edge, beating the edge of the plate partially into the ship's side, but without any actual penetration, or without any part of the plate being thoroughly separated from the main body. The chord of the arc within which the three blows were struck, measured 23in., and the depth of the arc was 12in.

Testing of English and Foreign Armour Plates.—The firing at the English and foreign ships' armour took place at Portsmouth on the 20th ult. The plates consisted of 4½-inch plate, from the Thames Ironworks Company, cut in two parts, one part bent two inches traversely from a straight line, and the remaining part not bent; a 4½-inch plate, from the Mersey Ironworks, and two other plates, one of 5½-inch and the other of 4½-inch, from Mr. Begbie, of London. All the plates were of excellent quality. The bending of the half of the Thames plate did not appear to have injured the metal any further than if it had been rather incautiously heated. The metal in the bent portion had a greater tendency to crumble under the blows of the shot than the unbent portion. The Mersey plate was also excellent, and stood some severe pounding without penetration being made. The two plates furnished by Mr. Begbie, however, beat all the others. The 5½-inch had five shots planted in a space of 17 inches by 12, but no thorough penetration was made, nor were there any cracks of consequence. The 4½-inch plate had seven shots in a space of 3 feet by 22 inches, with only surface cracks. This plate stood magnificently, and the way in which the metal stretched under the blows of the shots without cracking was astonishing. One shot struck the plate on the edge at the upper corner, but instead of breaking or cracking the metal, as is usually the case under such circumstances, it merely bent and expanded it without a sign of crack or flaw of any kind. The incidents on these two plates were rather under the ordinary depth. The metal, where pounded by the shot, had a peculiarly white, silvery, and soft appearance.

Krupp's Guns.—The breech-loading 110-pounder gun (says the *Army and Navy Gazette*) rifled in the Royal Arsenal on the service (Armstrong) system, which was cast solid and then hammered at the works of Messrs. Krüpp, at Essen, has passed the endurance proof as well as the service one, but shows a slight flaw in the interior. This may have been caused by rifling, and would, in the case of a built-up gun, be of no moment, but must be regarded with some suspicion, and can hardly be considered safe in a solid weapon, that would, if burst, fly into fragments. We much question whether any guns without coils or hoops over the breech will be sufficiently safe for use in the 'tween decks on board ship. There must be absolute safety in firing the high charges, by which alone armour-plates can be pierced; and this safety, although the interior tubes fail, has only been obtainable hitherto by building up. The want of a better interior for the guns was clearly pointed out several months since, in a lecture given by Mr. Anderson, at the Royal United Service Institution, and at which he made his proposal to use "steel," rendered tough by the application of oil. At the head of the factories, as Mr. Anderson now is, we may therefore look forward to a superior class of heavy ordnance being produced; but whether the internal portion of the gun will be a steel tube or a Krüpp casting hammered afterwards, seems doubtful. If steel or Krüpp's metal can be produced of sufficient size and toughness to form the whole front and inner breech in one mass, a great advantage will result both in the expense and in the power of the guns to withstand the blows of hostile shot upon their exposed portion; the breech could then have a coil over it, which would always render the gun safe against breaking in pieces, and causing destruction to the ship and crew.

STEAM SHIPPING.

Trial Trip of "The Kate," Twin Screw Steamer.—The trial trip of this new vessel, which has been looked forward to with much interest in nautical circles, came off on February 28th. The *Kate*, built by Messrs. Dudgeon, is an iron vessel of 500 tons B.M., her length between perpendiculars is 165ft., beam 22ft. 6in., depth in hold 13ft. 6in. She is fitted with separate and independent engines of 60 horse-power each, 26in. cylinders, and 21in. stroke; has two three-bladed screws of 7ft. 6in. in diameter, 14ft. 6in. pitch, and 9ft. 6in. apart from centre to centre. Her engines are exactly the same as the *Flora*. She is, however, 15ft. longer, has a long flat floor and tolerably square bilges, is rigged as a fore-and-aft polacca schooner, her masts constructed to lower by a joint near the deck, telescope funnel, and wire rigging. Her draught of water on this occasion was 7ft. 2in. aft, and 5ft. 4in. forward. The blades of her screws were now entirely immersed, exposing about 9in. above the water. At 12.15 she cast off, and, as her head was up the river, afforded those on board an opportunity of judging of the facility of the twin screws afforded for turning from a state of rest, and also for extricating a vessel quickly from a difficult and awkward position. From the time the warps were cast off until she made her half turn, and was under way down the river, about two minutes ten seconds elapsed. A single screw vessel, vainly endeavouring to execute the same manœuvre, just outside of her, appropriately exemplified the vast superiority the double screws impart, and the difference formed a marked contrast that was closely observed by all the naval authorities on board, affording an incident that fully satisfied them as to further results. The day was exceedingly fine, with a light easterly breeze, and the tide on the last of ebb. The *Kate* averaged twelve knots on her passage to the Nore, the engines making 120 revolutions. Upon reaching the Nore light-ship, Mr. Dinnen of the Admiralty, commenced the trials. The first was running from the Nore to the Mouse light-ship, 7½ nautical miles; this was accomplished in 37 minutes, giving an average speed of 12 knots an hour, the engines, which were also constructed by Messrs. Dudgeon, working beautifully at from 120 to 129 revolutions, with a vacuum of 25in., and the pressure of steam 20lb. It must be remembered in comparing the speed of the *Kate* with the *Flora*, that the former is a much larger, longer, and out of the water loftier vessel, and with but the same power of engines. After reaching the Mouse, the more important trials of manœuvring, with a view of showing the advantages of the twin screw system as applicable to vessels of war, were commenced. The first was describing a circle with both screws working ahead full speed, and the helm hard to starboard; this she accomplished in 3 min. 48 sec.; the circle described was about 400 yards in diameter. The second trial the port engine and screw were stopped, and the starboard driven ahead full speed, and she described the circle in 3 min. 58 sec. At the third trial the starboard engine and screw were driven ahead full speed, and the port astern, when the circle was accomplished in 4 min. 16 sec. Upon the

fourth trial the starboard engine and screw were driven ahead full speed, the port engine and screw astern full speed, and the helm kept amidships; by means of her screws alone she described the circle upon her own centre in 6 min. 55 sec. The fifth trial was made by turning the port engine and screw ahead, and the starboard astern, with the helm hard-a-port, when she described the circle in 4 min. 17 sec., turning on her centre. The sixth trial consisted in experimentalising upon steering the vessel by her screws alone, without any assistance from the rudder, when it was most satisfactorily proved by going ahead, astern, and turning to port and starboard, that the vessel was under perfect command. In that part of the trial in which she steamed full steam astern, one of the river buoys was selected as the point to steer her for by the screws, and universal satisfaction was expressed at the manner in which she performed this manœuvre. The return trip from the Mouse to the Nore light-vessel was accomplished in 35 min. 15 sec.; so that, taking the state of both wind and tide, twelve knots an hour appears to have been her average speed throughout the day.

TRIAL OF THE GALWAY MAIL STEAMER "COLUMBIA."—This paddle-wheel steamer, one of the Atlantic Royal Mail Company's fleet, underwent her official trial on the 4th ult., in Stokes Bay. The *Columbia* has been thoroughly overhauled and strengthened in every department, and, among other improvements, the whole of the condensers and air pumps are new, and are now worked by large eccentrics. The work connected with the hull has been executed by Messrs. Laird and Sons, of Birkenhead, and that of the machinery department by Messrs. Ravenhill and Salkeld. The following are the results of four runs at the measured mile. First run, 4 min. 16 sec., equal to 14·229 knots per hour, 20½ revolutions; second run, 4 min. 56 sec., equal to 12·162 knots per hour, 20½ revolutions; third run, 3 min. 59 sec., equal to 15·063 knots, 21 revolutions; fourth run 5 min., equal to 12·000 knots, 21 revolutions; giving a mean of 13·487 knots. Pressure of steam, 25lbs.; vacuum, 24½; indicated horse-power, 4000. Her draught of water forward was 19ft. 9½in.; aft, 19ft. 2½in.; the mean draught being 19ft. 6½in. She had 860 tons of coal on board, and 65 tons of water and spare gear. While at full speed the vessel made a complete turn in 6 min. 55 sec.

THE LIVERPOOL, NEW YORK, AND PHILADELPHIA STEAMSHIP COMPANY have recently added a new steamer to their line, called the *City of Cork*, built by Messrs. Denny, of Dunbarton, of 1550 tons; and the new steamer, *City of London*, of 2560 tons, by Messrs. Tod and McGregor, is expected on the station in about another month.

THE PENINSULAR AND ORIENTAL COMPANY.—A Bombay paper states that the value of the Peninsular and Oriental Company's fleet may be estimated at £3,000,000, their leasehold and freehold property at £1,100,000, and their coal depôts at £340,000. Their gross revenue is about £2,000,000 a year. The company have 20 stations, and their offices, machinery, fuel depôts, and docks at many of these stations rival Imperial establishments for their magnitude and convenience. They have the most lucrative goods and passenger traffic of any carrying company in the world.

LAUNCHES OF STEAMERS.

LAUNCH OF STEAMSHIPS FOR CHINA.—On the 4th ult. the *Quang Jung*, a fine paddle steamer built for the Anglo-Chinese fleet, was launched from the yard of Messrs. Laird, Birkenhead. Her dimensions are:—Length, 184ft.; breadth, 24ft.; depth, 13ft.; tonnage, 525 tons; power of engines, 150 horses. The model is designed to made a fast and handy vessel, both at sea and in the rivers. She has a straight stem and elliptical stern. The deck, fittings, &c., will be of the same style and quality as in Her Majesty's service. There was also on the same day floated out from one of the docks of the same works another steamer built for the same fleet called the *Tien-tsin*. Her dimensions are:—Length, 150ft.: breadth, 25ft.; depth, 12ft.; tonnage, 445 tons; power 80 horse. The engines are those for which Messrs. Laird were awarded a medal at the International Exhibition.

THE "SOUTHERNER," a fine model screw steamer, was launched from the yard of Messrs. Pearce and Lockwood, Stockton, on the 8th ult. The *Southerner* is of 1953 tons, O.M.; length over all 294ft., 8in.,; breadth, 38ft., 2in.; depth of hold, 22ft. The engines of 300 horse power, constructed by Messrs. Fossick and Hackworth, are fitted with superheating and feed heating apparatus, and other recent improvements. This is the largest vessel ever launched on the Tees.

LAUNCH OF AN ANGLO-CHINESE DESPATCH BOAT.—On the 6th ult. a despatch paddle steamer, ordered by Captain Sherard Osborne for his Anglo-Chinese fleet, was launched from the yard of Mr. J. White, Isle of Wight. Her dimensions are:—length between perpendiculars, 239ft.; breadth of beam, 29ft.; tonnage, builders measurement, 1000 tons. The engines, which are of 300 horse power, are constructed by Messrs. Day and Sons, of the Northam Ironworks.

RAILWAYS.

COLLISION ON THE MIDLAND RAILWAY.—On the 16th ult. a collision took place which fortunately did not terminate fatally, but which caused serious injury to several persons. The accident occurred on the Midland line, at Sawley junction, half way between Nottingham and Derby. Between eight and nine a coal train between Derby and Leicester broke down near to Sawley. It was followed by the 8.30 train from Derby to Nottingham, which came to a stand behind the coal train. Arrangements were instantly made for the passenger traffic to be worked on the down instead of the up line. Soon afterwards the 8.30 train backed from the place at which the stoppage occurred to Draycott-station, and the pilot guard (who was on the engine) mistook a white light from the engine of the 9.20 passenger train from Derby to Nottingham as a signal from the pointsman to advance, and that all was right. The consequence was, that the two trains dashed into each other violently. None of the carriages were knocked off the line, but it was ascertained there were about ten persons more or less seriously injured.

THE DUBLIN METROPOLITAN RAILWAY, though a small, is one of the most important undertakings that Ireland has seen since the introduction of the railway system into that country. Its object is to connect all the great lines which centre in the capital, and to make extensions to the shipping quays, along which tramways will be laid. The present isolation of the existing lines is thus removed; the interchange of traffic, now difficult and expensive, is facilitated and cheapened, and a thorough communication established for passengers and goods. The project has the support of all the existing railway interests. The capital required is £556,000, divided into £10 shares.

RAILWAY COMMUNICATION WITH ITALY.—At one of the recent sittings of the Italian Chamber of Deputies at Turin, on the occasion of the discussion of the Budget of Public Works, General Menabrea applied that the funds for cutting through Mont Cenis should be carried up to 2,500,000f. instead of 2,000,000f., as fixed by the committee. The Chamber, feeling the importance of that great undertaking, acquiesced, in spite of its desire to effect as much saving as possible, in the application of the Minister. General Menabrea, in a very remarkable speech, summed up the situation of the undertaking, and the present state of the works. The length of the tunnel at Bardonecche, on the Italian side of the mountain, was, he said, on the 1st January last, 1274 metres (the metre is 39 inches English), of which 724 were executed by the ordinary means from 1857 to 1860, and the remainder—170 metres in 1861, and 380 in 1860—by the new mechanical means. On the side of Modene, on the French slope, the mechanical means had not been adopted up to the 1st January last, but, by the ordinary means, 925 metres had been excavated, making altogether a length of 2199 metres. At the end of January the new means were also brought into operation on the French side. General Menabrea expressed his opinion that the whole of the cutting may be completed in 12½ years, instead of the 25 years at first demanded, and recommended the Parliament to make the necessary sacrifices in order to attain that result, which was the more desirable for the Italian Government, as by the convention with France the latter is to pay a premium of 500,000f. for every year reduced in the maximum of 25 years, and of 600,000f. if the works continue for less than 15 years. While waiting for the tunnelling of the mountain the Italian Government has conceded to Mr. Zell, an English engineer, the construction of a railway on the present road over Mount Cenis, on a system of which he is the inventor, and which is described below. Mr. Zell, who is supported by Mr. Brassey, undertakes the affair at his own risk and peril. The concession of the Italian Government is not, however, valid, unless Mr. Zell obtains that of the French Government, which is equally interested in the undertaking, and he has already left for Paris in order to present his proposals to the French Government.

A RAILWAY ACROSS THE SIMPLON.—The Paris correspondent of the Brussels *Independance* writes:—The scheme for the passage of the Alps by railway over the Simplon, has been submitted to the Emperor, at the Tuileries. The plans are executed by the company of the Italian line, and the president, one of the directors, and M. Lehaitre, the engineer, had the honour of presenting it. The Grand Diana gallery had been placed at the disposal of these gentlemen, for the exhibition of the plans, which are forty metres in length. Some workmen had arranged along the whole length of this celebrated gallery, wooden ascents and cross-roads, by which were shown the general plan and outline of the route, so that the Emperor and the persons who accompanied him, could, in walking, follow upon the maps the projected line from Douro O'Ossola, in Italy, to Brigues, in the Valais, and so effect, in imagination, an actual passage of the Alps, upon a reduced scale, it is true, of two thousand. This great work was commenced on the 1st of August last year, and ended on the 7th. About forty agents, divided into two brigades, one turning to the north and the other to the south of the Alps, under the leadership of two engineers, have during four months explored the mountain, and traced the plan of the future railway, which is to pass over rocks, cross torrents, fill up valleys, gorges, and precipices, before which science does not hesitate. The stimulus of having a great work to accomplish has alone sustained the great men to whom the task was confided. They set up shelters and encampments in woods hitherto unexplored, carrying on their backs, beds, clothing, and provisions, as they had often to live two or three leagues from any dwelling. It was frequently necessary to lower by ropes down the precipices, the men who had to prepare the plans amid empty space, and the snow and avalanches more than once threatened to stop them summarily in their work. The result has been to put before the Emperor eighty kilometres of iron way in the Helvetic Alps, forty-four of which will be covered over, twenty-three in tunnels, and twenty-one in galleries. All these passages are ventilated either by shafts for the tunnels, or lateral openings for the galleries. These openings, cut at different points into arcades, have a startling appearance. They are veritable promenades a thousand metres above the sea, offering the same security as those of the Rue de Tivoli, which they resemble, but presenting a more picturesque and varied panorama. The execution of the plan, according to the author, would occupy less than five years. At the end of this month the complete project of crossing the Alps by the Simplon, will be officially submitted to the governments of France, Italy, and Switzerland. The estimated cost of this great project, including the fixed and rolling material, the interest of the capital employed, &c., is 72,000,000 francs.

THE GREAT RUSSIAN RAILWAY.—From the report of the council of administration of the Great Russian Railway Company for 1861-2, which has recently been published, the following is found:—The undertaking, upon which about £25,000,000 have been expended, on the faith of a 5 per cent. guarantee by the Russian Government, appears to be making good progress, the traffic having doubled in 1862 as compared with 1861. The extent of railway now at work is 1010 miles. Last year seventy-five mixed locomotives, forty-nine goods locomotives, and thirteen locomotives to be used at stations were ordered by the company; and, at the close of 1862, it was calculated that the company had 322 engines, of which 220 were employed on the St. Petersburg and Warsaw, and 102 on the Nijni-Novgorod line. The company had constructed a good deal of its plant, and many of its turntables, switches, &c., at its Leuchtenberg works, and fitting and repairing shops on a great scale were last year brought into operation at St. Petersburg.

SOUTH AMERICAN RAILWAYS.—The Peruvian Government have sanctioned a contract with reference to a line across the Andes, concluded with Messrs. Homberg and Co., of London, and Messrs. Bovan and Co., of Paris. An interest of 7½ per cent. per annum is guaranteed by the Peruvian Government upon the capital employed. The works of a line in progress from Santiago to Valparaiso, in the Republic of Chili, are being pushed forward with great activity, and the rails have been laid for more than half the distance between Santiago and Quillota, from which point a line to Valparaiso has been for some time opened for traffic.

INDIAN RAILWAYS.—The opening of the railway to Benares has so shortened the time taken by the post between Calcutta and Bombay that the direct mail steamer from Calcutta closes only three days, instead of a week, after the Bombay mail. On Lord Elgin's way to Benares, the Governor-General stopped at Nulhattee, and carefully inspected the light railway which has been laid down on an ordinary road from Moorshedabad by Mr. Wilson, C.E., engineer of the Indian Branch Railway Company. The gauge is only four feet, a first experiment in a system of railway construction which may yet revolutionise Indian transit. The same company are about to lay down a similar feeder of the East Indian trunk line from Cawnpore, through Lucknow, to the Gogra, which is at this point more navigable than the Ganges. A third very long feeder will start from a point about 60 miles from Delhi, and at right angles to the line pass through the rich Doab of the Ganges and Jumna to the foot of the Himalayas. But the longest of all will be a line parallel with the East Indian, to start from Buxar on the Ganges, and run direct up through Oude and Rohilcund, probably to Umballa. Instead of £12,000 a mile, the lowest average price of the guaranteed lines, these light railways will be laid down at £3500 a mile, of which the State will contribute £1000 in some shape or other as a subvention. All will be on the uniform Indian gauge of 5½ft., and will meet the insuperable difficulty of the want of wood by iron sleepers.

RAILWAY ACCIDENTS.

EXTRAORDINARY ENGINE CHASE.—An extraordinary occurrence recently took place on the Caledonian Railway, which had very nearly been the cause of a serious accident. An engine was detached from an up luggage train at Beattock station, and shunted on to the down line, for the purpose of taking in water. When this operation was completed, the driver, instead of going to the points and returning to his proper line, put on steam and started for the south alone. The fireman, who was on the platform, seeing that if the engine kept on it would inevitably meet the down limited mail face to face, lost no time in getting ready another engine, which fortunately had the steam up, and started in chase on the proper or up line. After a race of 13 miles he overtook the truant engine near Lockerby, and on getting alongside leaped from one engine to the other, both going at the rate of 15 or 20 miles an hour at the time. He had just time to reverse the engine, wake up the driver, who was asleep, and then run to the adjacent signal post, when the limited mail came thundering along from Carlisle at 40 miles an hour. It was fortunately stopped by the signal in time when within a few yards of the runaway engine. Had the fireman hesitated as to the proper cause to pursue, even for one minute, a very serious accident and loss of life must have occurred.

RAILWAY COLLISION AT WOLVERHAMPTON.—On the 8th ult. a railway collision happened on the Shrewsbury and Birmingham line, near to Wolverhampton. At 7.15 a.m. a local train left the Great Western Station in Wolverhampton for the Madeley and Wellington branch. Through a defect in the feed-valve too much water was taken into the boiler at Wolverhampton, and the train was stopped at the Wolverhampton locomotive works of the Great Western Railway, which are upon the Shrewsbury and Birming-

ham line, that this defect might be remedied. Care did not seem to have been taken by the persons in charge of the train to apply the stationary signal, which was close at hand, so that a London goods train, which was then due, might be warned off. In consequence, the goods train came on, unapprehensive of danger, and was between 100 and 150 yards only from the passenger train when the driver of the goods saw the tail of the passenger train. He shut off steam, reversed the engine, applied his breaks, and did all in his power to avert a collision; but in vain. Fortunately, the passenger train, when he came upon it, had begun to move; and to this circumstance, added to the promptitude of the goods train driver, is owing the circumstance that the collision has been unattended with fatal consequences. Singularly enough the persons injured were in the carriage the farthest removed from the point of collision, and the one which was coupled to the luggage-van, which followed immediately upon the tender of the passenger train. This was a second-class carriage. Its buffers were broken by the concussion against those of the luggage-van, and then the carriage was reared to the roof of the van, and the first compartment destroyed.

TELEGRAPHIC ENGINEERING.

The Indian Electric Telegraph Department is about to be thoroughly reformed, and the lines now in use are to be superseded by posts and wires of permanent construction. The reforms are due to the representations of the Bombay Government.

Telegraph in Sweden.—The official Swedish telegraph report states, that the Swedish telegraph (net) has advanced from 10 geographical miles, in 1853, to 689 in 1861; the total amount of wires being 983 geographical miles, while the number of stations has increased from two to sixty eight. In 1861 the number of telegrams was 169,038, the income 513,044, and the clear gain to the state 69,142 Swedish dollars.

Submarine Telegraph Company.—The Submarine Telegraph Company, during the half-year end 31st December last, transmitted 172,881 messages over their wires, against 137,714 for the previous six months, showing an increase of 35,167 messages. The receipts were £23,427 5*s.* 6½*d.*, against £18,517 18*s.* 8½*d.*, or an increase of £4909 6*s.* 10*d.* The returns of the current half-year contrast favourably with those of the corresponding period of 1862—the number of messages conveyed for the first six weeks being 34,680, as compared with 31,783, and the receipts being £4907 13*s.* 5½*d.*, as compared with £4194 19*s.* 5*d.* The proportion of the earnings belonging to this company, after paying the working expenses and repairs to cables, left a profit of £9500 16*s.* 7½*d.*; and deducting the interest paid on debentures and loans, and £1853 18*s.* 11*d.*, being 10 per cent. on the gross receipts for the reserve fund, there remains a sum of £5285 0*s.* 3½*d.*, equivalent to a dividend of nearly 5 per cent. per annum on the share capital. Following the same course for the liquidation of the balance of the suspense account (2300 15*s.* 11½*d.*), as was adopted in the last half-yearly accounts, viz., by applying the reserve fund, £1853 18*s.* 11*d.*, and the balance, £620 5*s.* 9*d.*, of last half-year's reveuue, amounting together to £2474 4*s.* 8*d.*, there is available a sum of £5458 9*s.*, from which a dividend at the rate of 4 per cent. per annum was declared, carrying over a balance of £1219 15*s.* placed to the credit of the reserve fund. The cable between Marsala, in Sicily, and Cape Carbonara, in Sardinia, has recently been successfully laid.

GAS SUPPLY.

The Crystal Palace District Gas Company have reduced their price of gas throughout the district commencing the 1st of January, 1863, and have also declared a dividend of six per cent. per annum, and a dividend of ten per cent. per annum on the ordinary capital of the company.

The Boston Gas Company propose a dividend at the rate of 8½ per cent. for the current year.

In Abergavenny, the price of gas is to be reduced from 6*s.* 10*d.* to 5*s.* 10*d.* per 1000 feet; the 10*d.* also to be deducted for prompt payments.

The Howden Gas Company have reduced their price from 7*s.* 6*d.* to 6*s.* 8*d.*, and have declared a dividend of 6 per cent.

The Bromley Gas Company have declared a dividend of 10 per cent., leaving a balance of £305.

The Kettering Gas Works have deemed it necessary to add a third gasholder to the two already existing, the accepted tender being C. and W. Walker; for £444.

CANALS.

The Suez Canal.—The efforts of the company are at present almost exclusively directed to the completion of the canal, by which fresh water will be conveyed to Suez. It branches off, near Lake Timsah, from the small canal, previously dug by the company, and which, will be remembered, is a prolongation of the Wadi Toumilat Canal. The watercourse is about 25 feet in width, with a depth of about five feet. It is already completed as far as the Bitter Lakes, and the engineers of the company expect to reach Suez before the middle of the coming summer. Their next task will be the construction of a feeding canal, starting from Cairo, and running along the edge of the Desert, the execution of which, though lately abandoned, has been finally decided upon. Without it, indeed, it would be impossible to maintain a sufficient level in the new canals, even while draining their neighbours, to the grievous injury of the cultivators dependent upon the latter for the irrigation of their lands. The sight of a stream of fresh water, flowing through the still and death-like solitude of the Desert, of itself offers a most singular spectacle. A practical end can also more readily be assigned to this portion of the company's projects. To the inhabitants of Suez the acquisition of fresh water and of the attendant means of vegetation will be a boon of real value, and, although new accessions of arable land are hardly yet an object of necessity to Egypt, yet the canals afford the prospect that many productive spots along their banks may yet be redeemed from the surrounding wilderness. Between the fresh-water canal and the *rigole*, or preliminary trench of the Maritime Canal, runs a small channel, about five feet wide and two to three feet in depth, which serves to supply the labourers with water, and which is lengthened as the work on either side progresses, being, however, always kept a short distance in advance. The cutting for the maritime *rigole*, through the ridge of the Serapeum, which, next to the Gisr, is the highest land on the course of the canal, will for a short time remain in abeyance, while the fresh-water canal is pressed forward. The cutting of El Gisr has been dug to a depth, at its highest levels, of about 70 feet, and it forms a channel containing a width of water of about 25 feet, with a depth of four to five feet. The trench is cut, as elsewhere in the desert, with its sides at an inclination of two feet for every one foot in depth. The ridge terminates towards the north in a plain covered with hillocks of light sand, which about four and a-half miles further on sinks below the level of the sea, and is now covered with a shallow sheet of water, communicating with lake Menzaleh. It is along these four to five miles of the line that the canal appears to be exposed to the greatest danger from land drifts. But it is maintained that the embankments which will be formed when the canal is excavated to its full width and depth will afford ample protection. As a further precaution, hedges of cane and brushwood are put up at various points across the plain. These, it is contended, will serve as barriers against the progress of the heavier particles of sand, which being raised by even the most violent storms at but a slight elevation, and moving at a low velocity, are brought to the ground on meeting with the least obstacle. The lighter particles, being lifted high into the air, are carried away over long distances, and on again falling to the ground are spread so lightly over the plain that it is contended they can be of little or no practical effect. The track of the canal along the greater part of its course through Lake Mensalch is clearly marked by the embankments, of which the bases have been raised on either side at a distance of 60 mètres across. Two small channels have been formed, one on either side, with a depth of water just sufficient to give passage to a small boat. The central portion of the canal is still untouched, and the mud which forms the bed of the lake frequently shows itself above the surface of the water. The embankments are made of this same mud, which was lifted by hand labour from the bed of the lake. Near Port Said the traces of the embankment become very slight, and in some places boats seemed to cross the open lake. The work is to be continued by means of dredging machines. The mud is raised in almost a liquid state, and is poured into a species of caisson formed of planks, supported by wooden piles driven into the bed of the lake. On rising above the level of the water the mud hardens into a solid mass. This portion of the work, as will be readily believed, has been attended with great difficulties and trouble, but the worst is believed by the engineers to be past. As the canal approaches Port Said it is to attain the width of 80 mètres, terminating in a basin or dock of 800 mètres square. This basin is likewise to be deepened by means of dredging machines. As yet only 16 machines have been put together at Port Said and along the canal, but it was stated that the number will shortly be raised to 50, and that each is expected to excavate an average of little if at all less than 1000 cubic mètres a day. The channel of communication with the sea will be 400 mètres wide, and its entrance is to be protected by a double jetty. The western mole is to be prolonged to a distance of 3400 mètres, or somewhat more than two miles, where it will reach a depth of water of 10 mètres, or about 32 feet. A small islet of stone has been formed at about half the distance as a nucleus to the future pier, and to serve for the discharge of the boats that come to Port Said with stone and other materials and stores. The temporary wooden jetty is about 200 yards in length, and is partially filled in with stone. The accumulation of sand that has been formed on the western side advances the beach to the extent of about 50 yards into the sea; but the engineers are disposed to attach but little importance to the matter. They argue that before the sand can reach the extremity of the mole it must fill up an angle formed by a basis extending to an almost unlimited length along the coast to the westward, and of an elevation of upwards of two miles. The stone required for the works at Port Said has hitherto been brought at an exceedingly heavy cost from the quarries of El Meks, near Alexandria. Future supplies are to be drawn from the hills of Genneffeh, near the Bitter Lakes, and to be brought in flat-bottomed boats along the canal, at an estimated cost of 14f. the cubic mètre. At Suez, it will be remembered, the intention of constructing jetties has been abandoned, and it is proposed simply to deepen the channel that leads from the anchorage to the town, a distance of about four and a half miles, and which is practicable for small boats alone. The channel is formed on its western side by a large sandbank, partially uncovered at low tide. At its further extremity the Messageries Imperiales have commenced the foundation of the dry dock, in accordance with their contract with the Egyptian Government. The dock will be connected with the shore by an embankment 2½ miles in length, already in course of construction, over the sandbank, and which will be surmounted by a railway. It seems a singular thing, considering the implicit confidence with which the success of the Canal Company appears throughout to have been regarded by the French public of all classes, as well as by the late Viceroy, that it should not have been resolved to await the completion of the improved channel, when the dry dock might be constructed close in shore on a far more convenient spot, and, of course, at a very much lighter cost. To return to Port Said. The site of the destined town is a narrow strip of land, which separates the sea from the lake, and, until lately, occasionally washed over by the sea. It is in process of being widened and raised beyond the reach of the waves. A foundry and workships, fitted up with every description of machinery, have been established at Port Said, and, together with the lighthouse, at the foot of the pier, the storehouses, *châlets*, and other light dwelling places built for the *employés*, impart a town-like appearance to the spot. Nile water is brought across the lakes in boats carrying iron tanks, but the place is before long to be supplied by means of iron pipes, which have already been brought to the Isthmus. The water is to be raised by pumping machinery in the neighbournood of Timssh to the summit of El Gisr, whence it will flow towards the north, following the embankment of the maritime canal.

ACCIDENTS TO MINES, MACHINERY, &c.

Colliery Explosion near Newcastle-upon-Tyne.—About six o'clock in the morning of the 7th ult. an explosion of gas occurred in Coxlodge Colliery, by which 19 persons have lost their lives. The colliery is situated at the north edge of the town moor, about a mile and a half from the town, and it is the property of Mr. Joshua Bower, of Leeds. The workings of the mine are very extensive, and it appears that at the time mentioned, 43 persons were working in the north-east division of the pit. Of these 19 were killed, and 24 escaped with their lives.

BOILER EXPLOSIONS.

Manchester Association for the Prevention of Steam Boiler Explosions.—At the ordinary monthly meeting this Association held on February 24th, 1863, the chief engineer presented his report. This report was a double one, embracing the month of January as well as that of February. Of this report the following is an abstract:—"During the last two months, *i.e.*, from January 1st to February 20th, the ordinary visits of inspection have been made, 2 boilers tested by hydraulic pressure, and the following defects discovered in the boilers examined, viz.:—Fracture, 4; corrosion, 45 (5 dangerous); safety-valves out of order, 8 (1 dangerous); water gauges ditto, 28 (2 dangerous); pressure gauges ditto, 19; feed apparatus ditto, 9; blow-out cocks ditto (mainly from neglect), 37 (1 dangerous); fusible plugs ditto, 1; furnaces out of shape, 3 (1 dangerous); blistered plates, 3. Total, 157 (10 dangerous). Boilers without glass water-gauges, 19; without blow-out cocks, 17; without back-pressure valves, 64. Three explosions have been reported since the commencement of this year, from which, however, no lives have been lost, nor any personal injury done worth mentioning. Not one of the boilers in question was under the inspection of this Association. "No. 1 Explosion.—There has been no opportunity of investigating the cause of this explosion, neither have any reliable reports been obtained, but with regard to No. 2 and No. 3; a personal examination has snbsequently been made of the boiler in each instance. No. 2 Explosion.—The boiler in this case was externally fired, and of plain cylindrical construction, the ends being slightly domed. The length was 5ft.; the diameter, 2ft.; and the thickness of the plates, three-eighths in the ends, and one quarter in the remainder. The cylindrical portion of the shell was composed of two plates, about three feet wide, laid lengthwise, and flanged at their attachment to the end plates, which were in one piece. The complement of fittings was most incomplete, the number of those omitted being greater than those supplied. There was no feed stop-valve, no feed back-pressure valve, no steam pressure-gauge, nor any tap for applying the indicator as a test of the actual pressure. The only fittings were, one glass water-gauge, and one safety-valve, the latter stated to have blown off at a pressure of 25lb. per square inch. The boiler had lately been purchased second-hand, and not put into regular work since its re-setting. In consequence of this, the feed pipe was not yet connected, and the boiler had been supplied with water poured in by hand at the safety valve when the steam was down. The engine was standing at the time of the explosion, but had been working about an hour previously. The results of the explosion to the surrounding property were, that the workshop in which the boiler was set, was laid completely in ruins, the chimney levelled to the gronnd, and the windows of a house on the opposite side of the street broken by the concussion. The boiler was rent into five pieces, one of which was blown across the street, and lodged upon the top of the opposite house, while the manhole cover was thrown upon the roof of a shed in another direction. With regard to the cause of the explosion, the primitive mode

of feeding the boiler naturally excited the suspicion as to the sufficiency of the supply of water; and with this view, therefore, a particular examination was made of the remaining fragments of the glass-gauge, the colour of the plates, and the position of the fractures; in addition to which, the circumstances attendant on the working of the boiler were inquired into. The result of this investigation was, that shortness of water did not appear to have been the cause of the explosion, and this conclusion was corroborated by further examination, as will be seen from the following particulars. The safety-valve, which was supposed to have blown off at 25lb. pressure, was found, on investigation, to have been loaded to upwards of 100lb.; the diameter being one inch, the proportions of the lever thirteen to one, the weight at the end 5lb., in addition to that of the lever itself. It is impossible to say, however, whether the valve had been free or not, since it, as well as the lever, had been blown away; and, as there had been no steam-gauge, the pressure must always have been a matter of uncertainty, and thus it can only now be concluded, that 100lb. on the square inch was the minimum. A boiler, however, of such dimensions as the one in question would, if well constructed, withstand a much higher pressure than that of 100lb. per square inch; but, in this case, the manhole had not been strengthened with any mouth piece, which consequently made a very weak point in the shell, and from which the explosion appeared to have arisen. Five rents had started from it, while the remaining fractures were all subsidiary to these, and nothing more than the simple development of them. The effect of the manhole would be to throw upon the plates of the shell, in the immediate vicinity of the opening, an extra disruptive strain of about ten tons, added to which, the cover being an internal one, there would be acting it an upward pressure of steam amounting to about five tons, and tending to drive it through the manhole. The cover was a bad fit, being much too rounding, in consequence of which difficulty had always been experienced in making the joint, and it had been severely tightened by a stout bolt, which left the impression of the heels of the bridge in the plates. When it is remembered that the thickness of the plates was only one-quarter of an inch, it will not be surprising that fracture should have occurred at the manhole, under the above circumstances, and the fact of five of the rents emanating from this point, and all the others being explicable upon the view that fracture commenced there in the first instance, it is thought to be conclusive that the mal-construction of the boiler, in not being suitably strengthened at the manhole, was the cause of the explosion. No. 3 Explosion.—The circumstances in this case were very similar to those in No. 2. The boiler was externally fired, and of plain cylindrical construction. The length was 7ft. 6in.; the diameter, 3ft.; while the plates varied in thickness from five-sixteenths to one-quarter. The boiler was made out of an old flue-tube, taken from an internally fired boiler, and the longitudinal seams in line. The fittings consisted of only one float, and one safety-valve, there being as in the previous case, no steam-gauge, nor any means of ascertaining the actual pressure. At the time of the explosion, the engine was not at work, but the steam was being got up in preparation for starting, and the boiler stated to have been amply supplied with water, which an examination of the plates and fractures, afforded no reason to doubt. As to the cause of the explosion, there could be no room for hesitation. The safety-valve, which was stated to have blown off at 50lb. pressure, proved to have been actually loaded to upwards of 200lb., the diameter being only three-quarters of an inch, the proportions of the lever, seven to one, and the weight with which the lever was loaded, 21lb. The manhole in this boiler, as in the previous one, was not strengthened by any mouth-piece, and the rents, as before, had started from this opening. Attention has already been called in these reports to the weakening effect produced upon the shells of boilers by unguarded manholes, as well as by openings cut in the plates at the base of steam domes, and a case of explosions from these causes previously recorded. All modern well-appointed boilers have, as a rule, their manholes strengthened by strong mouth-pieces rivetted to the plates, the surface for the cover-joint being faced; still, it is thought that the weakening effect produced upon the shells of boilers by steam domes has not, as yet, received sufficient attention, and although it may have proved hitherto comparatively harmless, that the gradual increase of pressure, now generally taking place, must shortly force the subject into notice, and thus prominence is given to the details of these two explosions with a view of showing the importance of the subject. The danger of working without steam-pressure gauges will also be apparent from both of the above explosions. The results of this explosion were curious rather than serious, and attested the force of atmospheric concussion produced by steam. A dwelling-house directly facing the boiler, and situated about 50ft. from it, had its four windows, two on the ground and two immediately over them, all dismantled. A shower of bricks had been projected through the lower window immediately opposite the boiler, and had left their scars upon the walls of the room inside, while the two upper windows were also blown in. This will not excite much surprise; but the other lower window was stated not to have been blown in but drawn out, and this was attested by the debris of the sash lying upon the ground in the yard, while it was added that a looking-glass standing in the room had been sucked out along with the window sash, and thrown upon the ground outside. The same apparent anomaly has been noticed with regard to explosions caused by gunpowder,—some objects being thrown away from the seat of explosion, and others drawn towards it. This is accounted for by the double action that takes place, namely, first an expansion, which causes pressure, and then a recoil, which produces exhaustion. Some objects are more susceptible to the effect of pressure than exhaustion, while others are the reverse, and each succumbs to that action to which it is able to offer the least resistance. Thus unguarded windows fall under the first action—viz.: that of pressure consequent upon the expansion, while outside shutters, adapted to resist external aggression, withstand the former, but yield to the exhaustion consequent upon the recoil. There were further signs on the roof of an adjoining shed of the force of atmospheric impact, consequent on the explosion. This shed stood at right angles with the dwelling-house, and extending toward the seat of the boiler, formed, with the buildings immediately adjoining the latter, nearly three sides of a square. A considerable portion of the side of this shed nearest the boiler was open, while the other sides were closed. The effect upon the shed was, that many of the stone flags, with which the roof was covered, were blown up, and, clearing the pegs which hung them to the rafters, slid down upon the lower ones, while others mounted the rafters only, and there remained. The portion of the roof affected was the side of the gable opposite to the open doorway, and most distant from the boiler, since that side presented a surface more nearly at right angles with the direction of the impulse than the other. These particulars, though not important in themselves, afford additional evidence of the high pressure at which the boiler must have been worked."

MINES, METALLURGY, &c.

PROCESS FOR OBTAINING FINELY-POWDERED METALLIC COPPER, BY M. HUGO SCHIFF. —To obtain finely-powdered metallic copper, mix a certain quantity of a saturated solution of sulphate of copper with some of the same salt in coarse powder, and some granular metallic zinc, and shake the mixture continuously and briskly; the cupric solution is decomposed by the zinc, which is changed into sulphate, and leaves the copper only in the form of a finely-divided powder. As a certain quantity of the excess of sulphate of copper is constantly dissolving, the decomposing action of the zinc continues while cupric salt is in solution. By this means large quantities of powdered metallic copper can be prepared in a very short time. When a certain quantity is formed, it is thrown on a filter and washed several times with distilled water freed from air, and then with alcohol; it is afterwards dried by pressure, guarded from air and heat, as the metal, when so finely divided, is very apt to oxidise. During the reaction heat is developed, and singularly accelerates the decomposition of the cupric salt, and after a few minutes the temperature becomes so intense as to render it impossible to hold the flask in the hand.

THE DESULPHURATION OF IRON IN PUDDLING.—The inferior quality of bar-iron obtained from the puddling of pig-iron reduced from iron ores rich in sulphur, or even from good ores when reduced with coal containing much pyrites, is well known to iron-masters, and many methods have been devised for the desulphuration of this iron in the puddling process. Among the best of these is the addition of binoxide of manganese; still this is liable to objection as it is infusible, and thus prevents its becoming thoroughly incorporated with the iron; moreover, commercial oxide of manganese often contains impurities which possibly may be taken up by iron in the puddling process, and influence unfavourably the quality of bar-iron produced. This subject has recently been studied by Prof. Robert Richter, of Leobon (Austria). Richter calls to mind the powerfully oxidising effect of litharge (oxide of lead), and its use to promote oxidation in many metallurgical processes. On experiment he finds that litharge will not only remove sulphur in the puddling process, but, what is equally important, it also oxidises the phosphorus contained in the iron, thus affording a most simple means of correcting two sources of the greatest annoyance to the ironmaster. The experiments were made at the forges of Count Donnersmark, at Frantschach, near Wolfsberg, in Carinthia, with pig-iron which contained so much sulphur that it was impossible to make it into puddled bar. The process of puddling was undertaken in two double puddling-furnaces arranged for burning wood. Each furnace was charged with 7 cwt. of this iron. To one of the furnaces there was added 3lbs. of sulphide of iron and ½lb. of phosphide of iron, in order to still further deteriorate the quality of the product. After complete fusion, 3lbs. of litharge was added to the furnace in which the sulphide and phosphide of iron has been placed, and on thoroughly mixing this with the charge, the iron commenced to boil finely—the litharge being deoxidised by the carbon. The reduced lead was immediately re-oxidised by the atmosphere, and by subsequent reduction and re-oxidation it again and again exercised its oxidising influence on the harmful impurities contained in the iron. There was soon formed an easily fusible slag, containing oxide of lead, which also exercised an oxidising influence upon the impurities contained in the iron, while at the same time the oxides thus formed united with the slag. After an hour and a half from the time of charging, the iron was made into balls, these were shingled, and without difficulty rolled into puddled bar. In the other furnace, in which the iron was puddled in the usual manner, it was two and a half hours before the puddled balls could be taken out of the furnace, and, notwithstanding the greatest care was exercised, these crumbled to pieces when struck with the hammer, and rolling into bar was not to be thought of. Besides this, the loss in weight when the litharge was employed was but 11 per cent., while in puddling this iron by the ordinary process the loss was 18 per cent. The puddled-bar obtained from puddling with litharge proved neither hot or cold short, and was of sufficiently good quality to be forged into iron for scythes. A repetition of the experiments gave a confirmation of these results. Richter adds that in some instances the use of metallic lead may, perhaps, be preferable to litharge.

APPLIED CHEMISTRY.

NEW PROPERTIES OF SULPHUR, BY M. DIETZENBACHER.—A small quantity of iodine, bromine, or chlorine modifies in a remarkable manner the physical and chemical properties of sulphur. It becomes soft and malleable at the ordinary temperature, and maintains this form for a long time. This modification of sulphur, discovered by M. Charles Sainte-Claire Deville, and by him called insoluble sulphur, is almost entirely transformed by this process. 1. By heating a mixture of 400 parts of sulphur and one part of iodine, to about 180°, and then cooling it, a sulphur results remaining elastic for a considerable time. By pouring the sulphur on a glass or porcelain plate, flexible laminæ are obtained. This takes place with even a much smaller proportion of iodine. Iodide of potassium acts in the same manner as iodine. Treated in this way by iodine, sulphur becomes insoluble in sulphide of carbon. The liquor turus violet. 2. The action of bromine on sulphur is analogous to that of iodine; only instead of being black with a metallic lustre, the sulphur is of a wax-yellow colour, and is much softer, and remains soft. This modification is produced with 1 per cent. of bromine, and about 200° of heat. This sulphur is composed of from 75 to 80 per cent. of sulphur insoluble in sulphide of carbon. 3. By passing a current of chlorine on sulphur heated to about 240°, a soft kind of sulphur is obtained, easily drawn out, and the fragments of which readily adhere and unite With sulphide of carbon it behaves in the same way as sulphur treated by bromine. When freshly prepared, however, the sulphur, modified by the chlorine, yields about 10 per cent. more matter soluble in sulphide of carbon. After being worked up for one or more hours, sulphur hardens suddenly, and becomes completely insoluble in sulphide of carbon. These facts may throw light on some of the details of the manufacture of India-rubber vulcanised by sulphur and chloride of sulphur. Some of them confirm the results already obtained by M. Berthelot.

INFLUENCE OF OZONISED AIR UPON ANIMALS.—Dr. Ireland says:—"These experiments were most carefully performed, and all sources of complication avoided as carefully as possible; and, as I felt satisfied of their correctness, I saw no reason to sacrifice the lives of more animals in repeating them. I submit to the reader the following conclusions:—1. Ozonised air accelerates the respiration, and, we may infer, the circulation. 2. Ozonised air excites the nervous system. 3. Ozonised air promotes the coagulability of the blood, probably by increasing its fibrine. In the blood, however, ozone loses its peculiar properties, probably entering into combination with some of the constituents of the circulating fluid. 4. Animals can be subjected to the influence of a considerable proportion of ozone in the air for hours without permanent injury; but in the end ozone produces effects which may continue after its withdrawal, and destroy life."

COAL-TAR COLOURS—PEONINE AND AZULINE.—An additional colouring matter, from coal products, has recently been patented by Messrs. Guinon, Marnas, and Bonnet, of Lyons. The object of the invention is, in the first place, to transform carbonic acid into a red colouring matter, and then to convert it into a fast colour, capable of resisting acids and other agents. They take about 23lbs. of carbonic acid, from 10lbs. to 20lbs. of oxalic acid, and from 7lbs. to 14lbs. of sulphuric acid; this mixture is heated until the colouring matter is formed of the requisite consistence, the excess of acid is then removed with boiling water, when it assumes the state of a light pitch, with a green shade of cantharides. It may be dried and reduced to powder by exposure to the air, or by means of a stove. To convert this into a more solid matter, take 2¼lbs. of this less solid matter, and about 5½lbs. of ammonia of commerce. This mixture is then put into a closed metallic vessel, then heated to a temperature of about 270° Fahr. for about three hours. This is allowed to cool, and then the vessel is opened. The matter originally introduced therein becomes completely dissolved in the ammonia, thence yielding a liquor rather thick, and with a considerable colouring power. This liquor, when treated with acids, furnishes a deep red precipitate, which is the new matter modified as required. Thus "peonine" is applicable to the dyeing of silk, wool, &c., red. By combining five parts of peonine with about six or eight parts of aniline a blue colouring matter is produced. The mixture is heated to a temperature near the boiling point, which is maintained for some hours until the material is completely transformed. The result thus obtained is a blue colouring matter, which is purified by means of successive washings, first with acidulated boiling water, next with heated coal oil, and, lastly, with a dilute solution of caustic alkali. The matter thus obtained is passed into acidulated boiling water, then dried. It is then in the form of a powder, with golden shades, soluble in alcohol, methyle, and other spirits, and the solutions of which may be used directly for dyeing and printing. The inventors designate this new compound "azuline," and the blue produced by it is said to be very fine.

LIST OF APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF "THE ARTIZAN."

DATED FEBRUARY 24th, 1863.

496 H. Masters—Spools, bobbins, and rollers.
497 D Spink—Armour plates f r ships.
498 W. & H. Whitehead & H. Barber—Cutlery handles.
499 J. Clay—Saddles.
500 J. Hawthorn—Handles for doors, drowers, and other means of enclosure.
501 G. Davies—Melting and smelting furnaces.
502 W. E. Gedge—Hats.
503 J. W. Burton—Bearings and leashes of axles and shafts.
504 J Le-Butt—Dressing grain.
505 W. Hooper—Insulating and protecting telegraphic and other wires and rods.
506 D. B. Chatterton—Brick-making machinery.
507 E. R. Walker—Valves.
508 H. R. Willson—War and merchant ships.
509 G. A. Hoddart—Imparting heat to fluids.
510 A. Junger—Life-preserving garment.
511 T. Mallinson & J. Livingston—Throstle, spinning, and doubling frames
512 R. W Thomson — Obtaining and applying motive power.
513 G. Bower & W. Hollinshead—Apparatus for the production and trausmission of gas or other fluids.
514 W. Clark—Sewing machines.
515 W. H. Lapthorn—Reefing and furling ships' square sails.

DATED FEBRUARY 25th, 1863.

516 H. Wilde—Electro-magnetic telegraphs.
517 F. A. Gatty—Printing and dyeing cotton and other fabrics.
518 R. Maynard—Cutting and separating agricultural produce.
519 R. A. Brooman—Lamps for burning petroleum and other similar oils.
520 J. Fitter—Castors for tables, chairs, ond other furniture.
521 W. Readman—Carbonate of magnesia and of iodine ond kelp salt and other products from kelp.
522 E. B. Wilson—Alloys of titonium and iron.
523 J. B. Green—Paper.
524 B. Lawrence & W. Niblett—Regulating the flow of gas.
525 J. Gailey—Supplying air for mixture with gases and other aeriform fluids.
526 J. Edwards—Buttons
527 H. H. Henson—Mats.
528 T. V. Lee—Digging, compressing, and moulding peat or turf, and for retorts and kilns for drying peat or turf, and making peat or turf charcoal through the agency of hydro-caloric or superheated steam, and for collecting the products of distillation whilst charring the peat of torf.
529 W. E Newton—Producing stereotype plates for printing purposes.
530 W. Hudson & C. Catlow—Looms for weaving.
531 N Thompson—Sawing wood.
532 J. Inglis—Folding paper and other fabrics or materials.
533 A. Macivor—Veneering.
534 G. Tomkins—Tin and terne plotes.

DATED FEBRUARY 26th, 1863.

535 H. Edmonds—Ventilation of ships and vessels.
536 H. W. Brown—Window frames and glazing windows.
537 C Ritchie—Making spirol lighters or spills from wood or other substances.
538 G. H. Lilley—Securing together planks of wood applicable to the building and caulking of ships and other vessels
539 W A. Wilson & J. Smith—Furnace fire-grates.
540 A. Capello—Glazing Morocco leather.
541 A. P. Price—Blue colors
542 J. Yates—Armour plates or blocks for defensive purposes.
543 P Spence—Potash, alum, and other salts of potash.
544 W. Clark—Buttons.
545 M. Puddefoot—Tilling and cultivating land.
546 J. Humby—Oxide of zinc or zinc white.
547 R. J. Nodder—Hats, caps, helmets, military head dresses, and other coverings for the head.
548 F. H. Twilley—Book saws or holders.

DATED FEBRUARY 27th, 1863.

549 J. H. Allbinson & H. H. Cocker—Spinning, doubling, throwing, and reeling silk.
550 W. Stanleu—Converting certain fibres into a substitute for homan and other hair.
551 H. Fehr—Treatment of mineral oils.
552 E T. Hughes—Doubling or twisting yarn, thread, braid, and rope.
553 J. Carver—Fixing of combs in machines employed in the manufacture of bobbin net or twist lace.
554 J. A. Coffey—Controlling and facilitating locomotion on land and water.
555 J. Fry—Moshing machinery used in making fermented liquors.
556 R. A Brooman—Apparotus for boring into water and gos supply pipes, and fixing brauch pipes thereon.
557 A. Dudgeon, G. F. L. Meakin, E. E. Allen—Underground railways or subways, and carriages to be used therein.
558 W. Gray—Beaters for thrashing machines.
559 W. Clark—Pumping and forcing woter.
560 V. D. Delahaye—Cleaving and excavating pit coal aud rock or earth.
561 J. H. Johnsou—Treatment of hemp and other textile fabrics.

DATED FEBRUARY 28th, 1863.

562 B. West—Metallic pens.
563 G. Royle—Creasing or making rouches.
564 W. Hadfield—Steam boilers.
565 J W. Friend—Gas meter.
566 T. Fatra—Skirtiogs.
567 J. Maxfield—Brewing.
568 S. Williamson—Furnaces.
569 D. Collinge—Cleaning, streaming, and preparing cotton to be spun.
570 E. Paine—Facilitating the cleaning of vessels' bottoms while afloat
571 T. E. Symonds—Screw-propelled ships.
572 J. Penn—Relief valves to the cylinders of marine and other steam engines.
573 J. Courtenay—Obtaining motive power.
574 E. Hayes—Supplying water to surface condensers of marine engines.
575 S. Bateman—Wire rope and cordage.
576 G. Haseltine—Sewing machines.

DATED MARCH 2nd, 1863.

577 O. Murrell—Generating steam in boilers and other vessels.
578 F. Tolhausen—Cloth blunkets.
579 J. W. Barton—Refining and purifying oils.
580 A. F. Pagny—Agricultural implement for cultivating tubercles, roots, aud all oil plants.
581 G. Hawksley & T. Bissell—Powder chargers.
582 E. Habel & E. Suckow—Preparing, spinning, and doubling cotton.
583 T. Taylor—Fabric, and its application to the formation of ornaments for fire stoves.
584 C. Garton—Applying heat in the manufacture and refining of sugar, malting, hop drying, brewing, distilling, and vinegar making
585 J. S. Wells—Stockings aud other looped fabrics.
586 W. Clark — Preparing and obtaining photographic impressions.

DATED MARCH 3rd, 1863.

587 T. E. Symonds—Steering ships.
588 T. Emmott—Mules for spinning and doubling.
589 R. Saunders—Metal sheathing for ships and vessels.
590 G. P Lyster—Mooring buoys.
591 R. H. Jones & J. Abrahall—Bracelets and brooches.
592 G. Davies—Polishing soap.
593 J. Henderson—Carpets.
594 G. Price & W. Dawes—Burglar proof safes and strong room doors and frames.
595 J. Sibert—Winding and measuring lace.
596 G. Lamb—Recording the revolutions of the propelling shaft of a steam ship or vessel.
597 T. Erich—Pressing peat.
598 D. B. Parsons—Reaping and mowing machines.
599 B. S. Cohen—Protecting the points of pencils.
600 W. Parsons—Dining tables.
601 J. Pollard—Dressing warp yarns in the loom.

DATED MARCH 4th, 1863.

602 C. M. Palmer & J. McIntyre—Applying and fastening metal sheathing to the bottoms of iron ships or vessels.
603 J. F. Gits—Furnace for the revivification of animal charcoal.
604 A. P. Jeune—Spring bed bottom.
605 J. de Keyser—Producing a greasy substance.
606 T. H. Morrell & J Williamson — Purifying noxious vapours.
607 E. A. Wuusch—Treating sea weed.
608 P. Adie—Measuring angular and actual distances
609 E. W. Binney—Pressure and pump lamps.
610 E. W. Binney—Lamp burner.
611 W. Clark—Sulphuric acid.
612 W Hamilton—Registering suitable for advertisers' purposes.
613 J. Craig—Detecting and detoining thieves, ond indicating the presence of fire.
614 W. L. Tizard—Curvated armour plates.

DATED MARCH 5th, 1863.

615 W. Whittle—Nails.
616 T., E., & R. Thornton—Preparing wool for spinning.
617 J. Clinton—Flutes.
618 W. Allen & W. Johnston—Grinding cards employed in cording engines.
619 R. D. Dwyer—Springs for beds and seats.
620 E. P. Plenty & W. Pain—Supporting screens and straw shakers.
621 W. Wells—Horse shoes.
622 W. Jackson & R. Watkins—Steam engines.
623 S. H. Foster, T. Bunney, & J. Anderson—Looped fabrics.
624 J. Miller—Horticultural buildings.
625 E. B. Wilson—Steel.
626 T. W. Osborne—Lamps.
627 J. Howie—Crossings of railways.
628 W. Clark—Fire arms.
629 J. Elsey—Winding of lace on to the work roller in bobbin net or twist lace machines.
630 C. Clay—Chain harrows
631 J. Morris & T. Newton—Refrigerators
632 W. H. Buckland—Producing gas for illuminating and heating purposes.

DATED MARCH 6th, 1863.

633 M. Jourdin—Engraving by electricity.
634 A. Cuthell—Self-acting dampers for steam engine furnaces.
635 A. W. Mokinson—Locomotive and stationary engines.
636 A. Wilson—Easy, lounging, and invalid chairs, seats, or settles.
637 W. E. Gedge—Steam engines.
638 G. T. Bousfield—Illuminating gas.
639 D. W. Ransom—Fixing artificial teeth.
640 T. Hancock—Receptacle for gold, silver, and other coins.
641 H. R. Spicer—Preserving the bottoms and sides of ships.
642 T. G. Webb—Articles of pressed glass.
643 A. V. Newton—Elastic carriage wheel.
644 W. E. Newton—Metol casks.

DATED MARCH 9th, 1863.

645 H. Whittles—Collecting the condensed steam or waste water from places where steam is used and returning the same to the boiler.
646 R. Mushet—Treatment of pig or cast iron.
647 J. Cowley—Bricks, pipes tiles, and mouldings.
648 H. A. Bonneville—Removing stains from cloth and other materials.
649 J. Isherwood—Working presses for making up yarn in bundles
650 J. Haworth—Breaks for omnibuses and other carriages.
651 C. H. Lea—Opening and closing the gates of railway crossings.
652 W. Inglis—Steam boilers and engines.
653 P. Hugon—Obtaining and applying motive power.
654 Sir A. Keller—Reeling silk direct from cocoons on bobbins.
655 W. J. Clapp & N. Coats—Armour plotes.
656 J R. Gorst—Carriages.
657 W. E. Newton—Laying of wooden floors.
658 J. H. Johnson—Treatment of certain fibrous vegetable substances with a view to the production of textile materials therefrom.

DATED MARCH 11th, 1863.

659 H. Fletcher—Cleaning aud preparing cotton for spinning.
660 R. T. & R Mouteith—Making dyes from aniline and its analogues.
661 F. Cooke—Hats or coverings for the head.
662 R. A. Brooman—Voltaic belts and bandages.
663 J. Cassell—Moderator lamps.
664 G. A. Fulton & J. Clyde—Dry gas meters.
665 W. R. Mulley—Sheathing iron ships, caissons, and other like structures.
666 H. Wilson—Shaping wood.
667 W. Wood — Ornamentation of pomfret or liquorice cakes, rolls, and sticks.
668 A. Barclay — Locomotive boring and winding engines.
669 A. Barclay—Traction engines.
670 J. Werge—Indicating any regolated maximum or minimum degree of temperature.
671 J. Tomlinson—Opening twisted yarns and woven fabrics.
672 J. Rawshow—Dressing, raising, and brushing silk and cotton velvets, velveteens, cords, plushes, and other frilled fabrics.
673 W. Rossetter—Back beam warping machines.

DATED MARCH 12, 1863.

674 F. Baser-Krausbaar — Winding, cleaning, measuring, sorting, doubling, throwing, aud reeling silk.
675 H. D. & J. W. Taylor—Finishing woollen, worsted, ond other fabrics.
676 L. Desens—Bathing machine adapted for deep water.
677 W. Clark—Breech loading fire-arms.
678 E. H. Lomas—Action of charges or measure for powder flasks, canisters, or other vessels.
679 J. Polkinghorne—Treating tin ores and matters containing arsenic.

DATED MARCH 13th, 1863.

680 H. B. Barlow—Looms for weaving.
681 J. Harris, J. Butler, & J. H. Fraser—Rolling armour and other plates.
682 C. T. & A. Lutwyche—Metallic pens.
683 J. Taylor—Fire bars and bearers.
684 J. B. M. A. Bourreiff—Transferring by the means of typography colours and metals on surfaces in general.
685 W. H. Stubbe—Governors for marine and other engines.
686 A. Wydler & C. Thornton—Printing and dyeing woollen fabrics.
687 J. H. Johnson—Fastenings for harness.
688 W. Smith—Cultivating land and sowing seed.

DATED MARCH 14th, 1863.

689 W. E. Gedge—Plough.
690 F. Rudrum—Apparatus for registering.
691 W. West—Valves.
692 J. Page—Taps or valves.
693 J. W. McCarter—Sawing wood.
694 J. Tangye — Portable hydraulic punching machines.
695 R. Alexander—Mariners' compasses.
696 J. C. Richardson—Ships.
697 W. Young—Type composing and distributing machines.
698 R. Morelnad—Making extracts of hops, and selecting or separating the seeds and pollen from hops.
699 J. Walworth—Cleaning and drying Egyptian wheat, beans, ond other kinds of grain or seeds
700 W. Boaler—Colouring matters for dyeing and printing.

DATED MARCH 16th, 1863.

701 E. Oliver & G. Myers—Lowering and disengaging boats from vessels.
702 F. Hoyos — Stove or fire-grate for heating, cooking, and boiling.
703 T. W. Willett—Reefing and furling square sails of ships and vessels.
704 W. Vernon—Communicating signals or intelligence to or from railway trains or other similar conveyances, whether they be stationary or in motion.
705 G. P. Beley—Discharging projectiles below the water line of navigable vessels aud other structures.
706 T. Powell—Chopping block for butchers.
707 J. Smethurst—Construction of ships and vessels, for the purpose of obtaining additional motive power.
708 W. E. Newton—Iron and steel.
709 W. G. Eavestaff—Pianofortes.

DATED MARCH 17th, 1863.

710 J. H. Brierley & B. Greenwood—Cricketers' clasp.
711 J. H. Brierley & B Greenwood—Album belt.
712 W. H. Atkinson—Studs.
713 W. E. Gedge—Framing pictures and looking glasses.
714 W. H. Emett—Processes for facilitating and combining the art of writing with engraving together on stone.
715 J. Cox—Swimming baths.
716 W. E. Newton—Cure of scab, foot rot, and other diseases of sheep and cattle.
717 G. de Laire—Brown colouring matters.
718 T. N. Miller—Heating horticultural buildings.

DATED MARCH 18th, 1863.

719 W. Symington—Roasting and treating coffee and other organic substances.
720 W. C. Wild & J. H. Raudel—Inlaying gold and other metals in glass, and a composition suitable for the manufacture of jewellery and other ornaments.
721 W. Dunbavand & D. Crichton—Looms for weaving.
722 J. Roberts & R. Naylor—Organs, hormoniums, aud pionofortes.
723 R. A Brooman—Spoons and forks.
724 F Richmond, H. Chandler, & J. G. Richmond —Washing potatoes and other vegetables
725 W. E. Taylor—Reeling, winding, warping, and beaming yarn.
726 H. Kilshaw—Looms for weaving.
727 B. Wren—Cleansing and treating certain descriptions of wheat and other grain.
728 E. Legris—Thrashing out the seed of flax.
729 T. Oldknow—Jacquards employed in bobbin net or twist lace machines.
730 F. Norrington—Girths or bands and knee caps for horses.
731 W. Lorberg—Treatment of rags.
732 A. Morel—Generating carbonic acid.
733 J. D. & A. P. Welch—Bleaching, reducing, and brightening the colour or tone of dyed straw plaits and straw.

DATED MARCH 19th, 1863.

734 G. Haseltine—Boots and shoes.
735 E. Lever—Composition for the coating and preservation of canvas and other materials to make them water proof and non-inflammable.
736 H. Wilde—Steam boilers.
737 H. O. Houghton—Drying and cooling grain and seeds.
738 J. Saunders & J. Piper—Tin and terne plates.
739 S. L. Crocker—Yellow metal sheathing nail or spike, which by means of a nail cutting engine is cut from yellow sheathing metal.
740 C. Webster and W. Forgie—Clearing out the interior of foul chimnies or flues when on fire or otherwise.
741 G. H. Smith—Sewing machines.

DATED MARCH 20th, 1863.

742 W. Reay, jun.—Concentric bell amalgamator.
743 R. Couchman—Supporting or carrying ladies' parasols ond bags.
744 A B. and A. Morton—Injecting ond ejecting fluids.
745 J. and T A. Nield—Core barrels.
746 R. A. Brooman—Beating and drying wool and other textile and filamentous substances.
747 V. Houghton—Lamps aud lamp wicks.
748 G. Wilson—Springs.
749 G. Coles, J. A. Joques, and J. A. Fanshawe—Washing and wringing cloths or fabrics.
750 C Pryse and D. Kirkwood—Breech loading fire arms.
751 J. Brigham and R. Bickerton—Reaping and mowing machines.
752 F. de Wylde—Manufacture of cement from gypsum.

DATED MARCH 21st, 1863.

753 I. M. Evons and W. T. Griffiths—Ventilating mines.
754 F. and A. Roberts—Agricultural implements.
755 C. de Groote—Lamps with circular burners or wicks for the combustion of petroleum, schist, and other volatile oils.
756 G. A. Biddell—Traction engines to be used on common roads.
757 E Hartley, J. Clegg, and T. and J. Melledew —Looms for weaving.
758 J. M. Hetherington—Combing cotton and other fibrous materials.
759 F Applegate—Making certain indications in railway carriages.
760 F. Applegate—Time indicators.
761 W. Clark—Separation or obtaining of ammonia from azoted matters in the preparation of manure.

DATED MARCH 23rd, 1863.

762 H. Hancock—Range for making gas, cooking by gas, and lighting.
763 J W. H. and E J. Rothwell—Heating the feed water of steam boilers.
764 W. Johnston — Apparotus for lighting and heating.
765 T. G. Grant—Ovens.
766 J. Evles—Cheffouier bedsteads
767 W. Clark—Agricultural apparatus.

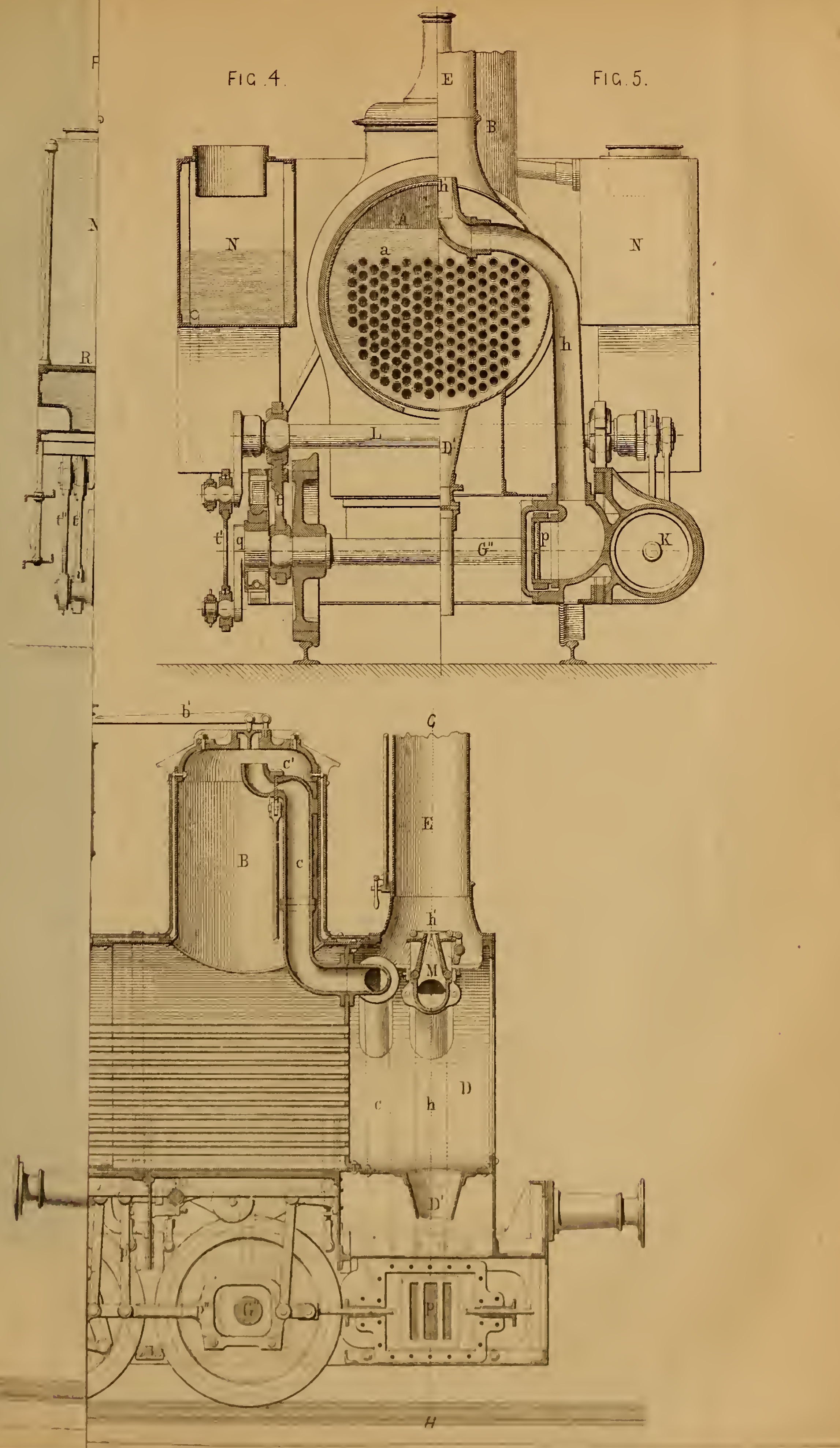


FIG. 4.

FIG. 5.

GOODS LOCOMOTIVE "STEIERDORF"

CONSTRUCTED AT THE WORKS

OF THE I.R. AUSTRIAN STATE RAILWAY Cº, VIENNA

FIG 2 FIG 3

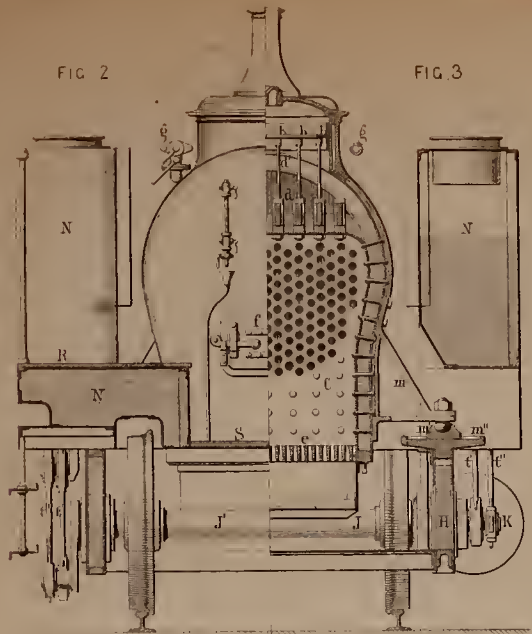


FIG 4 FIG 5

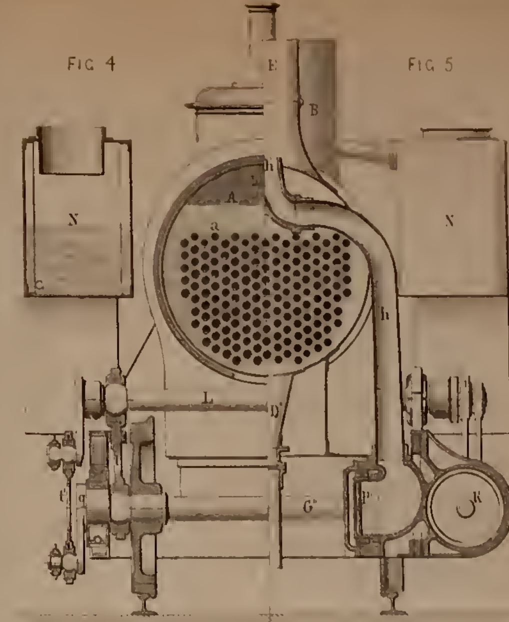
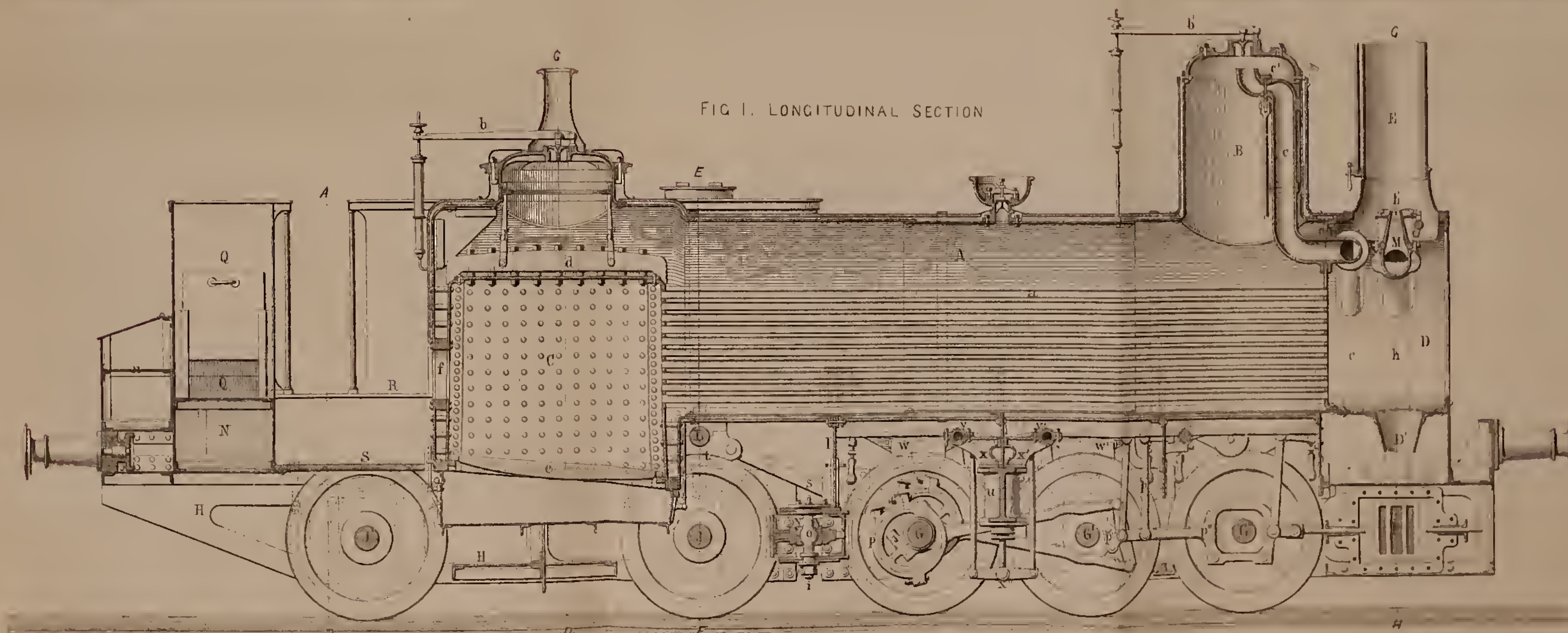
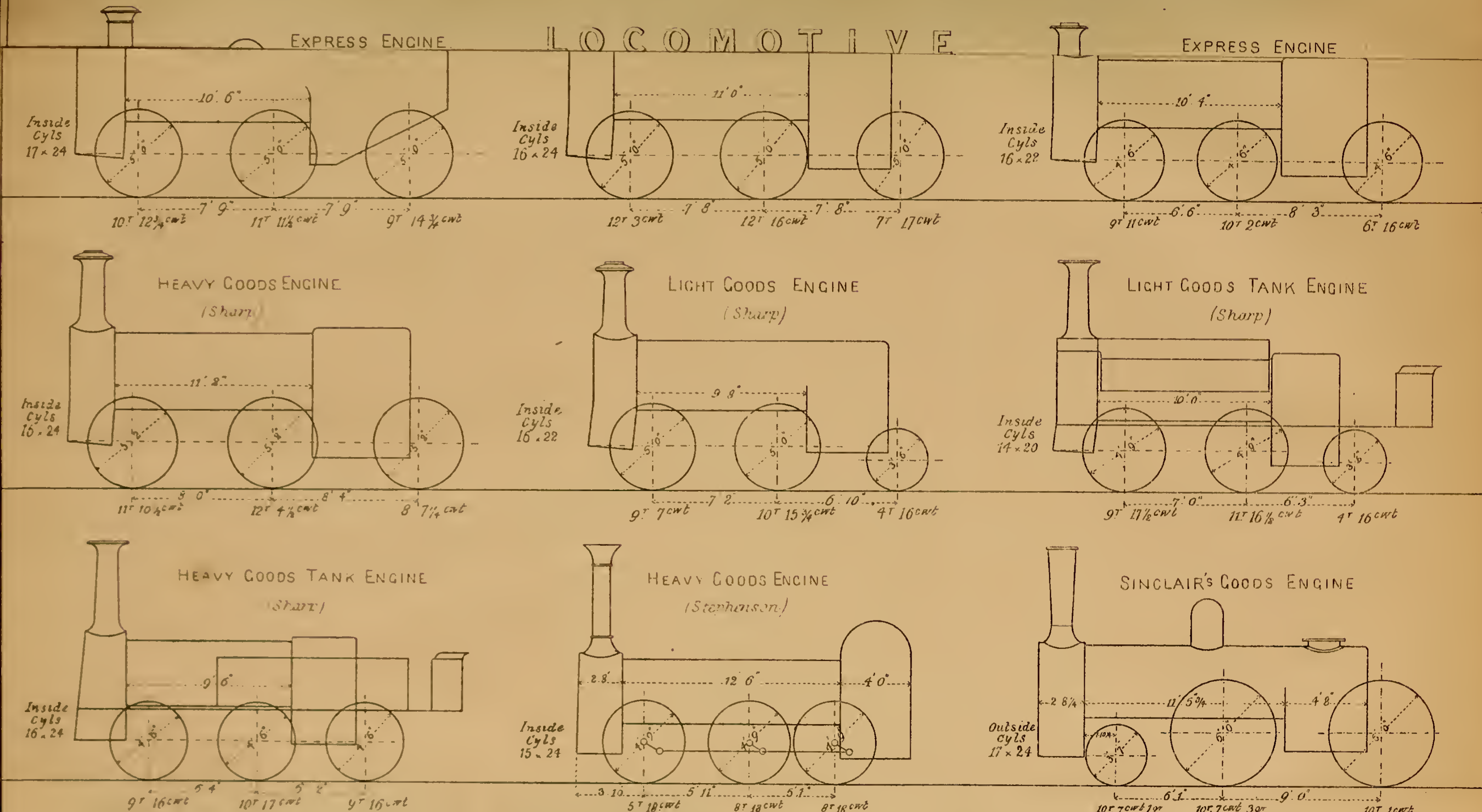


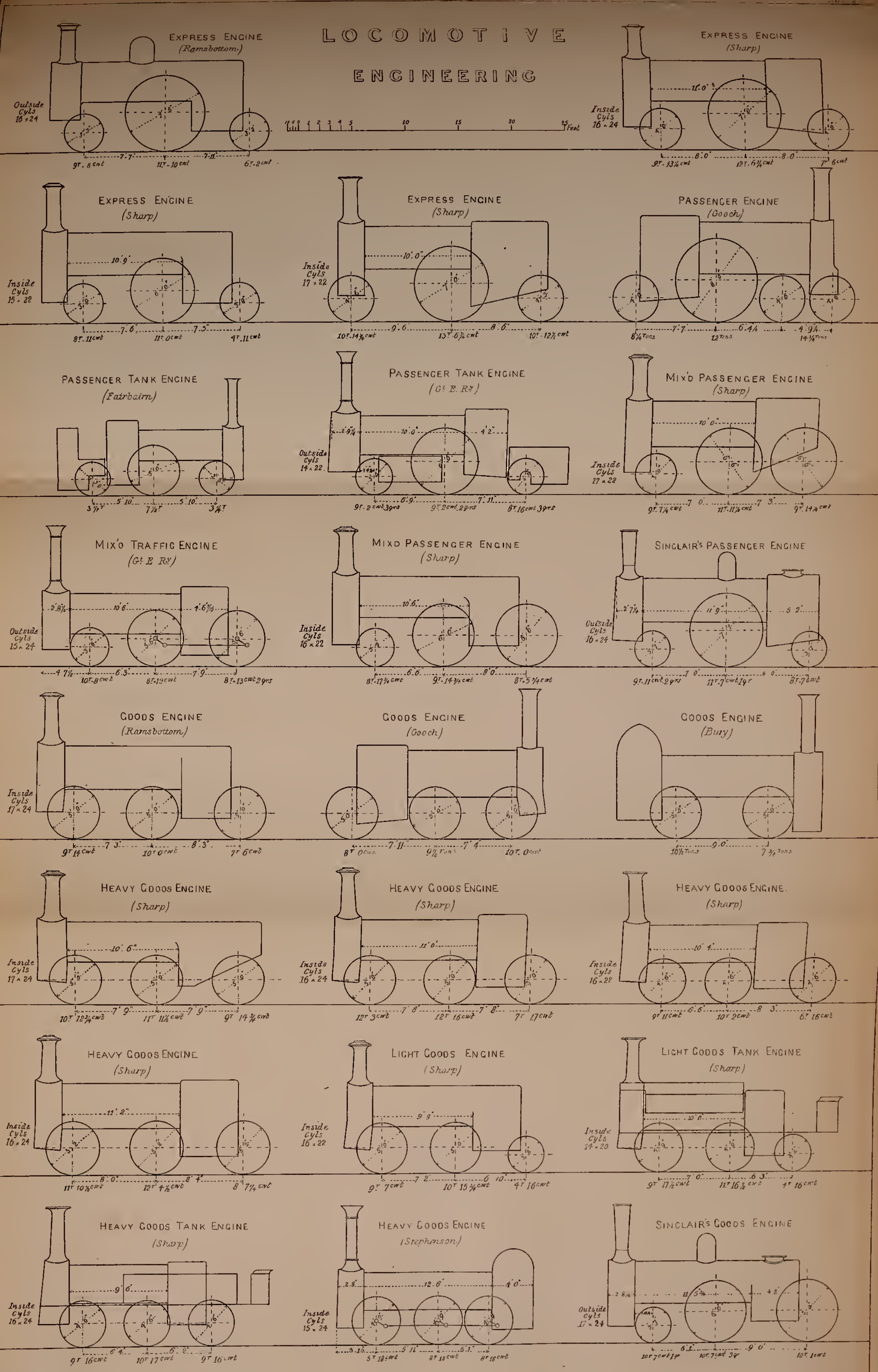
FIG 1. LONGITUDINAL SECTION



LOCOMOTIVE



W. Smith C.E. direx



W. Smith C.E. direx

// THE ARTIZAN.

No. 5.—Vol. 1.—Third Series.

MAY 1st, 1863.

GOOD'S LOCOMOTIVE, "STEIERDORF."

Constructed at the Works of the I. R. Austrian State Railway Company, Vienna.

(*Continued from page* 50.)

(*Illustrated by Plate* No. 240.)

In The Artizan of March we gave (Plate 233) an elevation and sectional plan of the "Steierdorf," accompanied by a series of descriptive particulars and details as to construction, dimensions, &c.

In Plate 240 with the present number, Fig. 1 is a longitudinal section taken through the barrel of the boiler.

Fig. 2, one-half of a cross section taken on the line A B, Fig. 1.

Fig. 3, one-half of a cross section through the fire-box on the line C D.

Fig. 4, one-half of a section through the fourth axle on the line E. F.

Fig. 5, one-half of a cross section through the cylinders, &c., on the line G. H.

In the following description we refer also to Plate 233; the same letters of reference are used in both plates to denote corresponding parts in the several views. A is the barrel of the boiler; B, the steam chest, containing the steam pipe c with the regulator c', and the safety valve b' above it; the fire-box C is strengthened by the stays d and suspension irons d'; its lower fore-end has a slight obliquity inward, so as not to be touched by the wheels of the fourth axle; two Giffard's injectors g g (Figs. 2 and 3, Plate 240) are used as feed pumps; D is the smoke chamber enclosing the inlet and exhaust pipes c and h, and the variable blast pipe h'; a funnel D′ is fitted to the bottom of the smoke-box, to allow of the removal of any cinders which may enter through the tubes. This operation is performed by means of a valve opened from outside. The main frame F rests outside the wheels, on the three forward axles G (G being the driving axle) G′ G″, and supports the steam cylinders and moving parts, together with the fore part of the boiler; it is strengthened by means of longitudinal and cross plates Z Z, and by angle irons. The three forward axles each support a pair of driving wheels; they are supported by bearings in the frame F; the wheels are cast iron, and furnished with cast steel tyres, the counterweights being cast with the discs; k k are the springs connecting the main frame with the axles. H is the second or after frame, and rests upon the axles J J; it carries part of the barrel, and the tank for water and fuel. The width of this frame is sufficient to allow of the bearings for the support of the supplementary axle L; the bearings for the axles J and J′ are also formed within the lower portion of this framing. k k are the springs connecting the bearings with the after framing H. o is the pivot bolt, and y the cylindrical socket. l l, &c., are the struts fixed on the engine framing, and forming a support to the barrel of the boiler. K K are the steam cylinders (which, as will be seen, are outside the framing); p the slide valves, and p' the eccentrics. p'' the expansion link suspended on the frame by means of an oscillating rod; p''' are the slide rods suspended to the rods p''''; r r are the connecting rods actuating the cranks q, which are fixed on the axles according to Hall's method; q' q' are the coupling rods, and s s' t t' parts of the coupling gear connecting the axles of the engine frame with those of the tender, through the supplementary axle L.

The steam break fitted to the "Steierdorf" consists of two vertical steam cylinders, u u' (Fig. 2, Plate 233, and Fig. 1, Plate 240), placed perpendicularly to the engine below the boiler, so as to be acted upon at pleasure by the driver. When the steam is admitted into these cylinders, the levers X X (shown in dotted lines) are actuated, and the brake blocks, w w_1, press upon the wheels G G. When the steam is let out, the whole of the mechanism recovers its former position by its own weight. The break blocks and levers on each side of the engine are connected by means of the shafts V V. The effect of the break can be increased by a counter-pressure from M, the exhaust valve in the smoke chamber, which can be readily operated by the driver. (This contrivance was made by Herr Zeh, of the Elisabeth Westbahn, to allow of admitting steam into the cylinders even when descending long gradients, and prevent at the same time the wear of the pistons by working without steam.) N N are the water tanks, Q Q the receptacle for coals, and n the tool-box on the tender. R is the platform for the driver, S that for the stoker.

The reason for connecting the whole of the five pairs of wheels of this locomotive has been explained in our March number.

It had been deemed impracticable to have the five axles on the same frame, on account of the small radius of the curves to be traversed. The arrangement shown in the woodcut, Fig. 1, page 98, was, therefore, made in order to enable the two frames to have a motion independent of each other.

Thus in Fig. 2, supposing a to be the line of the centres of the wheels of the engine frame.

b ditto of the tender frame.

$o\ m = x$ the distance of the pivoting point o from the axle of the engine frame next to it.

$o\ w = y$ the distance of same from first axle of tender frame.

$c = x + y$, the distance of the last axle of engine frame from the first of the tender frame.

The position of the point o having to be fixed so that both a and b remain steadily ebords of the arc of circle, whenever the two frames turn round o, we get the following equations.

$$x \;.\; y :: b + y : a + x$$

$$x + y = c$$

$$\therefore x = \frac{c\,(b + c)}{a + b + 2\,c} \quad y = \frac{c\,(a + c)}{a + b + 2\,c}$$

For the "Steierdorf," $a = b$; therefore,

$$x = y = \tfrac{1}{2}\,c.$$

A four-wheeled carriage running alone when traversing a curve will endeavour to take the direction shown in Fig. 3, when the plane of the back wheels will form an angle with the tangent to the curve. The resistance to the motion of the wheels in a curve is due chiefly to the amount of the angle α and the sliding of the surface of the wheels against the rails. This resistance will be met with also in the arrangement, Fig. 4; in six-wheeled carriages, and when several carriages are connected together by means of a movable link, as shown. The result will, however, be quite different if the coupling, Fig. 5, is used, for in this case the five axles will take up such a position that the exterior wheels can run on their largest, and the interior ones on their smallest diameters. By this means the angle α will be reduced to a minimum, and the slipping of the wheels will be nearly prevented. The trials to which the "Steierdorf" have been subjected have proved very much in favour of this arrangement.

The coupling of the locomotive axles with the tender axles was first contemplated at the time of the construction of the Sömmering railway, (which combines very sharp curves with a gradient of 1 : 40). This principle was first successfully carried out by Herr von Engerth, who connected the engine and tenders by a set of gearings. This method, however, having proved too delicate, the gearings requiring too much time and attention, a Hanoverian engineer, Herr Kirchweger, proposed the scheme illustrated in Fig. 6. In this view, A is the tender frame, B the engine frame, both furnished with the usual draw bars. C is the upper frame, and includes both engine and tender. D is a false or supplementary axle fitted on the frame C, so that both its ends can be raised and lowered independently of each other and of the frame C. This raising and lowering of the shaft D is effected through wedges fitted on C, and acted upon by mechanism fitted on the fire-box and tender-frame. The rods g g connect the bearings of the axles m and n with the bearings of the supplementary axle; d d are the coupling rods between the cranks of the axles m and n and the false or supplementary axle. In this contrivance the distance between the bearings m n will always be the same, and the power can always be transmitted by means of the drawbars. In traversing curves the axle D will rise on one side and descend on the other through the increase of the distance of the axles m n. But it has been found that the complication of the mechanism, and its liability to frequent derangement, makes it unfit for practical purposes.

The arrangement proposed by Herr Lippert, in 1854, is based on the same principles as Kirchweger's, the supplementary axle, however, being suppressed entirely. The axles m n (Fig. 7) are furnished with double cranks b c, the

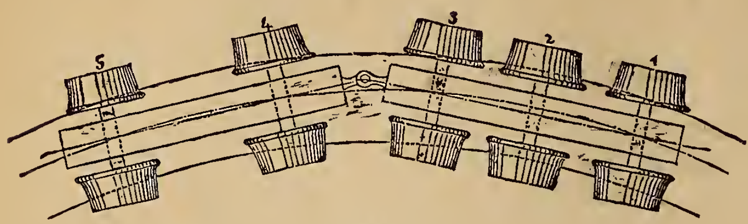


FIG 1.

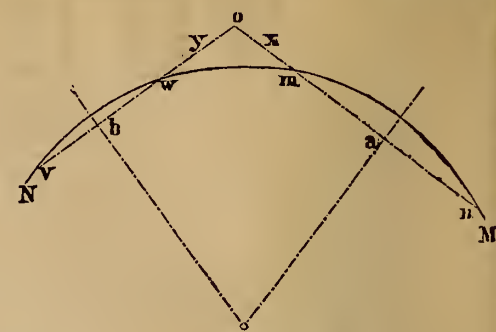


FIG. 2.

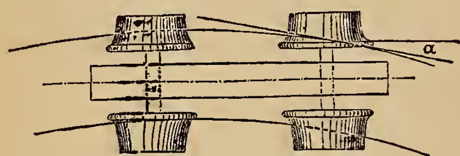


FIG. 3.

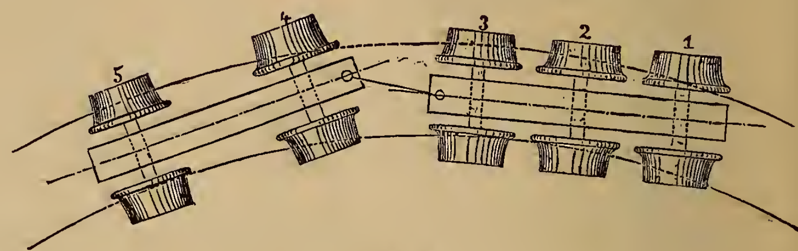


FIG. 4.

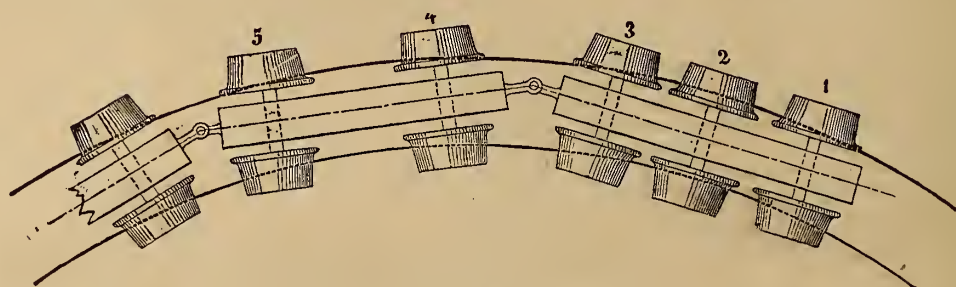


FIG. 5.

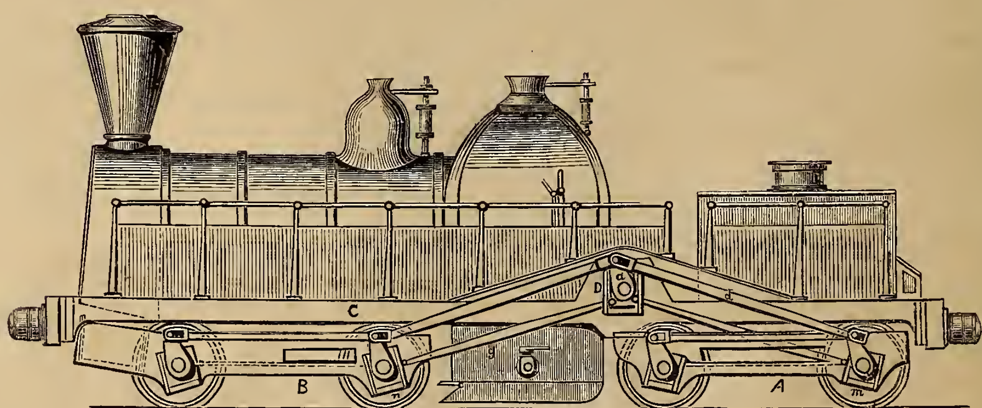


FIG. 6.

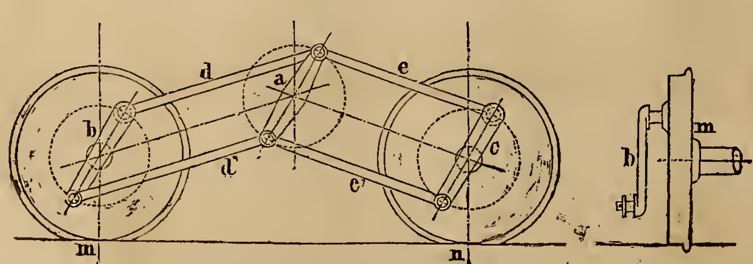


FIG. 7.

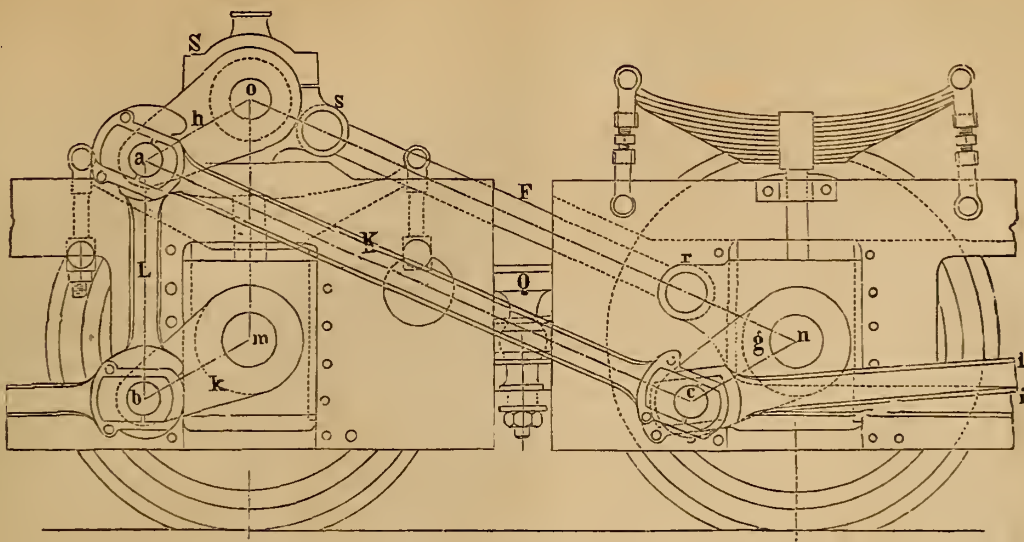


FIG. .

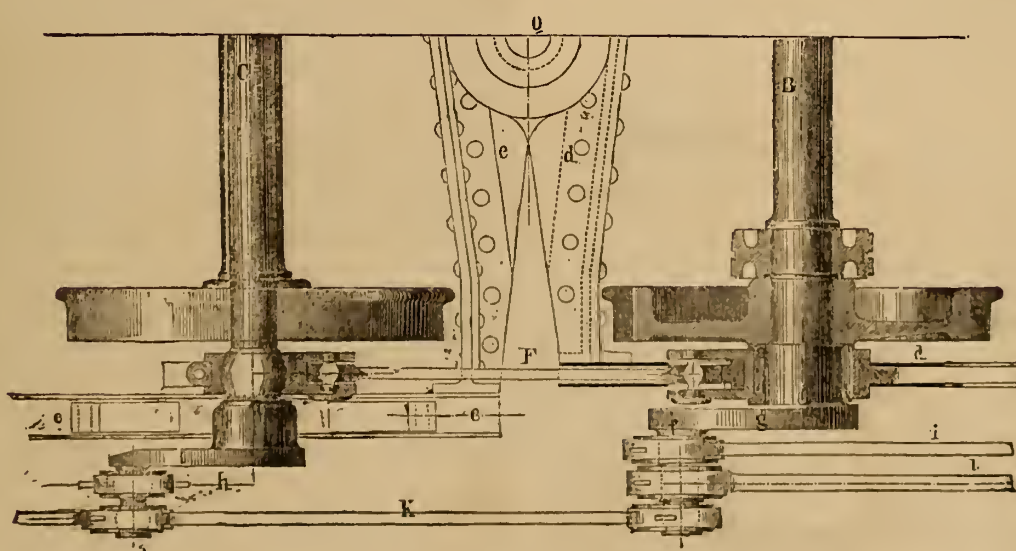


FIG. 9.

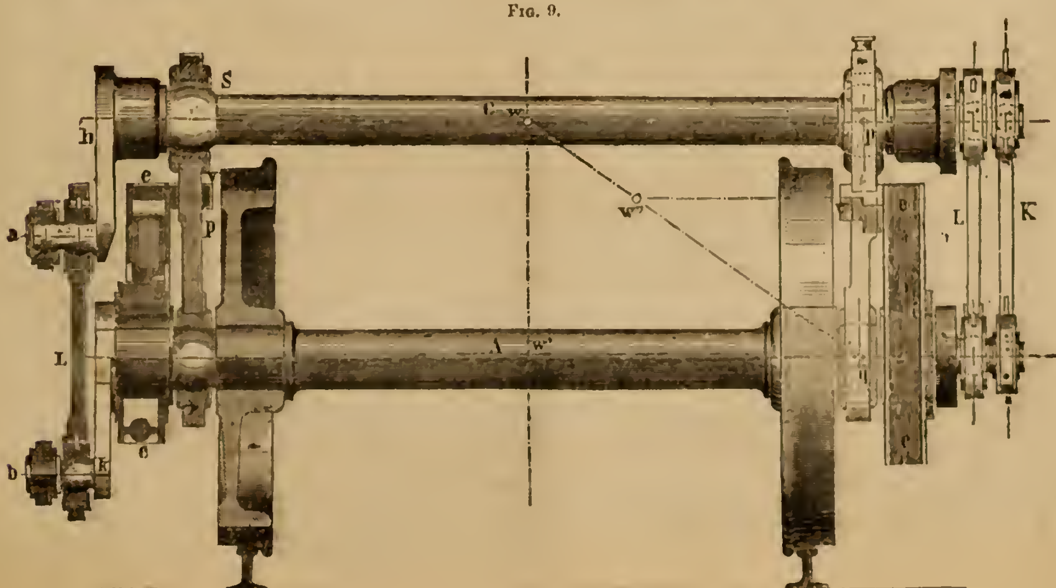


FIG. 10

intermediate shaft is replaced by the double crank a, while the rods d d', e e' connecting b and c with a, are substituted for Kirchweger's coupling rod. The realisation of this arrangement, however, proved quite as impracticable as the first named, although the principle it was based upon is unobjectionable.

In the "Steierdorf" the coupling has been effected upon a plan, the credit of the origination of which is due to Herr Fink, an engineer of the Austrian State Railway Company. This is illustrated by the accompanying wood cuts (Figs. 8 to 12), and also in Plate 240 herewith.

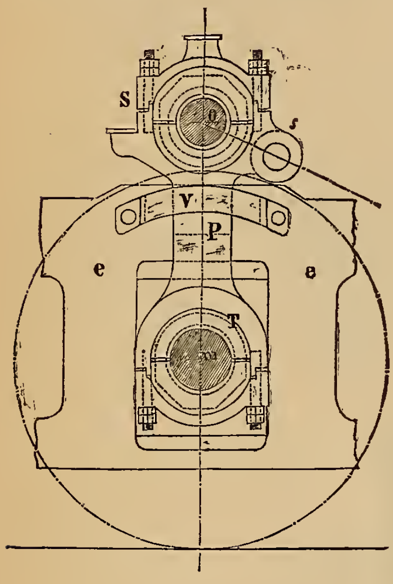
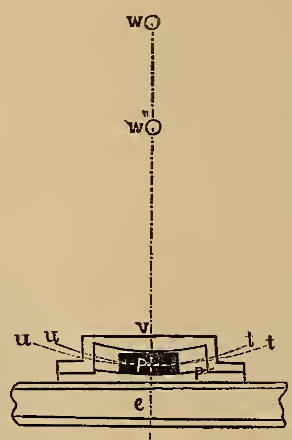


Fig. 11.



.12.

A is the first axle of the tender frame, to be connected with B the last axle of the engine frame. Q pivot bolt joining the two frames. C is the supplementary axle working in the bearings S upon the stays P, supported upon the axle A by means of the bearings T. The journals working in the bearings S and T are spherical, and allow the two axles A and C to alter their position relatively to each other. The bearings S and T are connected together by the rods F F; the extremities of the latter are connected with the bearings through the spherical bolt r s, so as to enable their position to be altered with respect to the axle of the engine frame. The supplementary axle is always kept horizontal in traversing curves, by means of the rods F and the stays P, the coupling of both frames being such, that when traversing a curve, one extremity of the axle A is brought nearer the axle B; the other extremity is removed from it to the same distance. The supplementary axle, however, being held at an equal distance from the axle B at both ends, through the intervention of the rods, F, the two extremities of the supplementary axle will have to move in opposite directions to the axle of the tender frame, but in each direction to an equal extent, carrying with them the stays P. When traversing a curve, therefore, the upper bearings of the oscillating stays P will each describe a curve of equal extent, but in opposite directions, and each of them will always descend to an equal extent, the supplementary axle C, thus always remaining horizoutal. v is a segmental guide for the vertical bearer P, fastened to the tender frame e (Figs. 11 and 12). In this guide the bearer P moves in such a manner, that while it revolves round the centre q of the lower bearing (Fig 10), the centre p of the upper bearing S of the supplementary axle describes a horizontal arc of a circle t v round the centre w of the axle C. The surface of the parallel slide v is, therefore, conical, or approximately a cylindrical surface, the horizontal section of which has w_{11} for its centre; the latter point is the intersection of the lines w q and a horizontal line drawn from v. K is an oblique coupling rod connecting the cranks of the axles B and C by means of spherical bearings, so as to admit of a lateral motion against the engine frame; the coupling rod L, joining the tender axle A to the supplementary axle is likewise furnished with spherical bearings.

The chief property of this arrangement is that the motion of the supplementary axle depends exclusively on the shafts which have to be joined; it, therefore, requires no particular mechanism which would involve a connection of the supplementary axle with either engine frame or boiler. This will be more clearly shown by the calculations upon which the arrangement of this coupling is based, and which we purpose giving in our next number.

A CRITICAL AND HISTORICAL REVIEW OF LOCOMOTIVE ENGINEERING.

By J. J. Birckel.

(*Illustrated by Plate* 241.)

(*Continued from page* 74.)

The Carriage.

The points to be watched in the construction of the carriage proper, and in the general arrangement of the engine, considered as a carriage, are the following, viz..—

1 Stability upon the rails.
2 Sufficiency of weight for the purposes of traction.
3 Transmission of the tractional power of the engine in the most direct manner possible from the driving axle to the train.

Now the causes which affect the stability of the engine are of two kinds, first, the position of the wheels underneath the machine, and the distribution of the load upon them; secondly, the disturbing element of the parts of machinery in motion, in connection with which may be mentioned the state of repair of the vehicle.

The earlier engines were supported upon four wheels only, placed between the fire box and the smoke box, and, as the barrel was invariably short, seldom exceeding nine feet, the wheel base was necessarily very short also, and the overhanging load of the firebox behind the driving wheel acted as a balance weight against the load upon the leading wheels, and when the engine was in motion it occasioned an oscillation round the centre of the driving axle known as the pitching motion, the result of which was to lift the engine from the rails in front, and to cause it to leave the track. It is a remarkable fact that Mr. Bury was the first to build an engine carried upon six wheels, as early as 1830, but, as the engine so constructed was too heavy for the rails then in use, it was condemned, and Mr. Bury continued to be, to the end of his career as a locomotive engineer, an unyielding supporter of the *four-wheeled* engine. Soon after this first experiment, however, it was found indispensable to put a third pair of wheels behind the firebox, to ensure the steadiness of the engine upon the rails, the weight of the latter being increased to meet the requirements of higher speeds and of greater weight of engines, which were gradually and of necessity being introduced. Four-wheeled engines are now seldom made for the ordinary purposes of railway traffic, though many of the class known as Bury's engines may still be found doing very useful duty upon our English lines of railway.

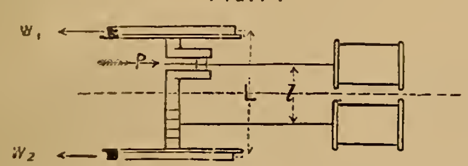
The duty of the front wheels being to guide the engine laterally upon the track, the nearer they are placed to the front end of the engine, or the less overhanging weight there is upon the guiding centre, the easier will be the work of leading the engine. It is the duty of the trailing wheels to prevent the pitching motion previously spoken of, a duty which they will perform more effectually the more they are kept backward, and thus we find that one of the means of ensuring the steadiness of the engine is to provide a long wheel base. To this, however, there is undoubtedly a limit imposed by the unavoidable necessity of running round curves, and to define that limit is a question that can be solved by experience alone. Stephenson, in his evidence before the guage commissioners, stated that "the wheel base varies between 10ft. and 13ft. 9in., but the latter is too long." Since then, however, express engines have been built with a wheel base of 18ft., and taken on an average, the wheel base of modern engines for ordinary traffic is about 15ft. With respect to the *distribution* of the weight, it should be such that the load on the leading wheels be sufficient to keep the engine well to the rails, and that in uncoupled engines there be sufficient load upon the driving wheels for the purposes of traction; these are the leading considerations which should influence the general arrrangement of the wheel base; independently of them however, there are various causes arising from certain necessities of constructive detail, such as the length of the connecting rod, the adaptation of springs, &c., which greatly influence the position of the wheels, and consequently the distribution of the weight upon them. To make ourselves acquainted with the best arrangements to be adopted, we think that we cannot do better than to refer to actual practice which at this time must embody the experience of the last thirty years, and for the illustration of this portion of our subject, we have produced a series of diagrams (plate 241), illustrating various types of locomotives, with the distribution of the load upon each pair of wheels as taken from the practice of Messrs. Sinclair, Ramsbottom, Sharp, and others, and from an inspection of these it must be perceived that there is a strong tendency to keep the wheel base down to about 15ft., and to have a load of about 9½ tons upon the leading wheels.

The parts of the machinery in motion, namely, the crank, the connecting rod, the crosshead, the piston and the piston-rod, when unbalanced, give rise to a horizontal fore and aft motion, and inasmuch as their action is not in the longitudinal plane passing through the centre of gravity of

the engine, they give rise also to a horizontal lateral displacement, which manifests itself in a horizontal sinuous motion of the engine, during its progress upon the rails. The unbalanced portion of the crank, and so much of the weight of the connecting rod as rests upon the crank, have a tendency also, through the centrifugal force generated by their rotary movement, to lift the engine from the rails, and momentarily to reduce its tractive force through reduction of adhesion, but with the heavy engines now invariably built, this tendency is too trifling in its amount to affect the stability of the engine; far more important is the vertical component of the steam pressure, arising from the obliquity of the connecting rod, which cannot be balanced, and the upward action of which is only slightly mitigated by the interposition of the springs. It is stated by Mr. Clark that Messrs. Sharp and Roberts were the first to apply weights to the driving wheels of their engines towards the year 1837, with a view especially to balancing the centrifugal action of the revolving masses; and that Mr. Fernihough was the first, in 1845, to point out the desirability of balancing not only the revolving masses but the whole of the horizontally reciprocating masses, in order to avoid the fore and aft motion and the sinuous motion to which they give rise; it appears, however, that to Mr. Nollau, of the Holstein Railway, and to the late Mr. Poloneeau, of the Orleans Railway, is due the exact theory of balancing locomotives, which we are now about to develope to our readers.

In the adjoining sketch, shewing in plan a pair of driving wheels

FIG. 1.



with the crank axle and the cylinders connected with them, let L be the distance of the wheels, or rather the gauge of the rails, l that of the centres of the cylinders which are supposed to be placed inside, and P the total weight of the horizontally reciprocating masses belonging to one cylinder, including the sweep of the crank reduced to its value at the radius of the crank; the intensity of action of that weight upon each wheel is as the inverse ratio of the distance of its centre of motion to those wheels, and if w_1 and w_2 represent the weights at the radius of the crank, which, at each wheel, would be required to produce equilibrium, the condition of equilibrium is expressed by the following equation,

$$w_1 \frac{L - l}{2} = w_2 \frac{L + l}{2}$$

A second condition of equilibrium is that the sum of the balance weights at the radius of the crank be equal to the disturbing weight, which symbolically reads thus:—

$$w_1 + w_2 = P$$

whence by a very simple algebraic transformation we obtain,

$$w_1 = P \frac{L + l}{2L}$$

and

$$w_2 = P \frac{L - l}{2L}$$

which weights are to be respectively equal for both cylinders, since the disturbing masses are equal; if now, in the adjoining figure 2, the line $o\ c$

FIG. 2.

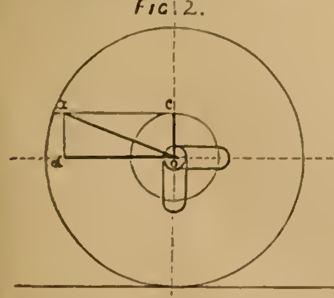
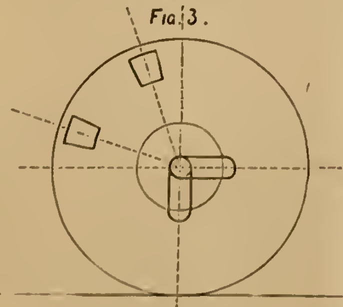


FIG. 3.

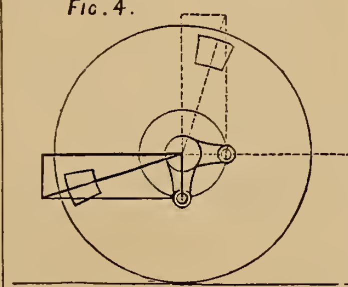


be made to represent the weight W_2 required for the crank on the off side of the engine, and $o\ d$ the W_1 required for the crank on the near side, the diagonal $o\ x$ of the parallelogram constructed upon these two lines represents in magnitude, and in direction the weight w required at the radius of the crank to produce the effect of the two weights W_1 and W_2 arithmetically the same may be determined thus:—

$$w = \sqrt{w_1 + w_2}$$

But as its position must still be determined by actual delineation, the arithmetical method of defining its amount need never be resorted to. When once the weight w at the radius of the crank is found, it is an easy matter to arrive at the weight actually required at the usual distance from the centre near the rim of the wheel, and in general the relative position of both counterweights in one view will be found somewhat similar to that shown in the sketch (fig. 3). When there is a coupling rod placed opposite the inner crank, its weight and that of the unbalanced portion of the wheel boss reduced to its value at the radius of the crank, may at once be subtracted from the weight W_1, and the operation afterwards proceeded with as in the manner above indicated. The problem of balancing outside cylinder engines may be solved in a similar manner, and if done so, it will be found that the balance blocks, as seen in one view instead of leaning towards each other from the far crank boss, lean from each other towards the far crank boss as in sketch (Fig. 4), in practice, however, it will not be found necessary to take into account the greater distance of the cylinders than of the wheels, the difference being generally very small, but it will be sufficient to apply exactly opposite the crank boss a counterweight capable of balancing the reciprocating masses at the crank pin.

FIG. 4.



The method of balancing locomotives with a view especially to avoid the horizontal sinuous motion leads to the application of a weight considerably too heavy for the revolving masses proper, and on that account some German authorities recommend to take an arithmetical mean between the weights as calculated for the case above considered, and for the centrifugal action only; this halfway measure, however, does not seem to us to have any claim to preference, especially when it is remembered that the vertically disturbing cause applied as above stated, is of no account. The method which we have given is that also recommended by Dr. Rankine in his work on prime movers.

At this stage of our inquiry, seeing that we have had occasion to speak of inside and outside cylinder engines, it may be proper to inquire into the several causes militating in favour of, and against the adoption of either classs of engines, and these may be briefly stated as follows:—

The position of the cylinders between the frames has the disadvantage already mentioned, of leaving but a very limited space for the valve gearing in the case of cylinders of large diameter, and in the case of engines with very large driving wheels, the necessity of providing room for the sweeps of the cranks and for the connecting rods raises the boiler, and, consequently, the centre of gravity of the whole machine to a height very injurious to the stability of the engine; in the earlier days of engineering also, when the tools and appliances for making crank axles were comparatively imperfect, that part of the carriage formed a very expensive item in its construction, and, as breakages were very frequent, the presence of the crank axle was considered to be a capital evil. In our days, however, the making of a crank axle is almost as simple a piece of work as the making of a straight axle, and since, owing to its improved construction, breakages occur less frequently, this no longer forms an objection against the inside cylinder engine. On the other hand, and as a set-off to these objections, the inside cylinder engine, through having the cylinders incased in the hot smoke box has the advantage of being comparatively free from the loss of useful effect caused by condensation of the steam, and since at the same time the reciprocating masses lie nearer the centre of motion of the engine, in a proportionately less degree do they tend to disturb its steadiness.

The outside cylinder engine obviates all the defects, above enumerated, appertaining to inside cylinder engines. It affords ample room for the valve gear, it allows the centre of gravity to be kept as low as possible, and the expense of renewing crank axles is avoided. It is questionable, however, whether these advantages can compensate for the loss of power caused by the condensation of the steam in the cylinders through their partial exposure to the cooling effects of the atmosphere. The diagram (Fig. 5) on next page, reproduced from Mr. Clark's work, where this question is very minutely entered into, and taken from an engine whose cylinders had been allowed to cool down, illustrates in the first place the actual loss of power, through loss of pressure during the working period, the dotted

lines showing what the diagram would have been had there been no condensation. This, however, is by no means the worst feature of the case, for it has been well shown by Mr. Clark that, during expansion a portion of the condensed steam evaporates again, a circumstance which, at first sight, *seems* to mitigate the evil just pointed out; that evaporation, however, continues also during the period of exhaust, and is productive

FIG. 5.

FIG. 6.

of an amount of back pressure which is so much the more injurious as it pervades the whole of the return stroke. The effect of condensation upon back pressure is conspicuously illustrated by the annexed diagram (Fig. 6), where the full lines show a diagram taken from a cylinder which had been allowed to cool down, and the dotted lines are taking from the same cylinder well heated and working at shorter expansion; placed in juxtaposition with each other, the illustrations (Figs. 5 and 6), are calculated to give the reader an adequate idea of the loss of power which may be occasioned by condensation, and of the importance of having the cylinder well protected, and though the cases illustrated are, perhaps, extreme ones, the reader may easily form for himself an idea as to the respective merits of either system on the score of economy of steam.

Formerly also when the theory of balancing engines was not properly understood, the disturbing effect of the reciprocating masses, formed the ground of great objections against the outside cylinder engine which now, however, no longer exists. As to the question of wear and tear it is argued that the outside cylinder engine docs not wear so well; that it knocks itself to pieces sooner than the inside cylinder engine, and certain it is that the frame connnections at the smoke box end require to be very strong and stiff to enable the frames to resist the great side strains thrown upon them; on that account also is it really more expensive in its first cost than the inside cylinder engine.

Among locomotive engineers opinions are pretty equally divided as to the predominancy of the merits of either system. Thus we find that Sinclair, Allan, and, we believe, Beattie, adhere to the outside cylinder engine; whereas Stephenson, Sharp and Fairbairn, wherever they have been allowed to carry out their own intentions, have decidedly adhered to the inside cylinder engine. Mr. Ramsbottom puts the cylinders inside in all his luggage engines, and in his ordinary passenger engines; but in the express engines, with 7ft. 6in. wheels, he puts them outside, evidently with a view to keeping the centre of gravity as low as possible. That in the case of express engines considerations of economy should yield to considerations of stability, and, therefore, of safety, seems to us to be sound engineering doctrine, which we should decidedly imitate, and which we cannot but recommend.

(*To be continued*).

ON A NEW SYSTEM OF CONSTRUCTING SHIPS, PROPOSED TO BE CALLED THE PARABOLIC CONSTRUCTION.

BY JOHN W. NYSTROM, C.E.

The construction of ships is yet in an empirical state, with no established rules for laying down the principal lines, but is wholly dependent on skill, experience, and taste of the constructor. In the parabolic construction herein proposed, positive rules are established for the principal lines, as the load water-line, rail in plan, cross-sections, displacement, sheer, &c., that when the lines are laid down by those rules, they cannot be improved by taking in or out a little more or less here or there; the rule makes the lines right. This will enable the young constructor to lay down ship-lines as fine as if made by the most experienced shipbuilder; still he will not be confined to any particular shape or proportion of the vessel, but can vary it according to his own taste and judgment.

The advantage of the parabolic construction is not only in laying down fine lines, but the simple calculations connected with it are of great importance, and enable the constructor, with but few figures, to go to work with the greatest certainty of attaining a correct result, without recourse to trial and error, or comparison with other vesssels. All the lines in a ship are combinations of the circle, ellipse, parabola, and hyperbola. These lines are derived from the conic sections, where they are curves of the second order, but herein we will employ them to any order whatever. The ordinary formula for a parabola is $y = \sqrt[n]{px}$, in which y = ordinate, x = abscissa, and p = parameter; the letter $n = 2$ in the conic parabola; it is called the *exponent*, and denotes the order of the curve. By assuming different values on the exponent n, different forms of parabolas are obtained. When $n = 0$ the parabola will be the two sides forming the right angle in a triangle; when $n = 1$ the parabola will be the hypothenusc in a right-angled triangle; when $n = 2$ it will be the true parabola in the conic sections; and when $n = \infty$ the parabola will again become the two sides forming the right angle in a triangle. The circle, ellipse, and hyperbola follow the same law, which enables us to form theoretically any line in the hull of a ship.

Referring to figs. 1 and 2, page 104, represent parabolas of different orders from 2 to 10, the vertex being at o, x = abscissa, and y = ordinate. Figure 1 shows load water-lines of vessels of different sharpness, of which the inner one is considered the sharpest form a vessel can have, being a conic parabola with the exponent $n = 2$. The higher the exponent is, the fuller will the lines be. Figure 2 represents cross-sections of vessels; the inner line is a conic parabola, and the others of higher order, same as in fig. 1. The order of the lines are marked on the drawing. The shading between every other line is to make it more distinct when selecting a desired sharpness. The water-lines and the cross-sections are precisely the same kind of lines; both can be laid down by the same ordinates.

Letters denote,

D = displacement of the vessel in cubic feet.
T = displacement in tons of salt water of 35 cubic feet to the ton.
Q = area of the greatest immersed cross-section in square feet.
q = area of any ordinate cross-section between Q and the stem or stern.
L = length of the vessel in the load-line.
l = length from Q to where the parabola meets the centre line.
l' = the whole length from Q to the stem or stern, including the hollow lines.
Z = measure of the hollow lines.
B = breadth of beam in the load-line.
b = half the beam B,
d = load draft of water, omitting the depth of keel.
δ = any draft of water corresponding with the displacement t.
t = displacement in tons at the draft δ
e = depth of centre of gravity of the displacement, under the water-line.
X = abscissa, y = ordinate.
All linear dimensions are in feet.
n = exponent for the parabola in the load water-line.
n' = exponent for the parabolas in the cross-section Q.
n'' = exponent for the areas of the ordinate cross-sections q.
r = index for displacement at different drafts.
a = area of load water-line in square feet.
k = co-efficient for speed and horse power.
M = nautical miles or knots per hour.
H = horse power required for the speed M.
A = area of the hull of the boat in square feet.
a′ = area of the upper deck, or any horizontal section of the hull at d' feet from the keel.
d' = depth from a′ to the keel.
Q′ = area of the greatest cross-section from the keel to a′, or the depth d'.
e' = depth of the centre of gravity of the hull from the top of d′, supposing the hull to be of uniform thickness.
a and e, see fig. 1.
m = height of metacentre above the centre of gravity of the displacement.

FORMULÆ.

$$y = l\sqrt[n]{\frac{x}{b}} \quad \ldots\ldots \quad (1)$$

$$x = \frac{y^n b}{l^n} \quad \ldots\ldots \quad (2)$$

$$n = \frac{\log. b - \log. x}{\log. l - \log. y} \quad \ldots\ldots \quad (3)$$

$$q = Q\left(1 - \frac{x}{b}\right)^2 \quad \ldots\ldots \quad (4)$$

$$\text{a} = \frac{n\,B\,L}{n+1} \quad \ldots\ldots \quad (5)$$

$$n = \frac{\text{a}}{B\,L - \text{a}} \quad \ldots\ldots \quad (6)$$

$$Q = \frac{n'\,B\,d}{n'+1} \quad \ldots\ldots \quad (7)$$

$$n' = \frac{Q}{B\,d - Q} \quad \ldots\ldots \quad (8)$$

$$D = \frac{Q\,L\,2\,n''^2}{2\,n''^2 + 3\,n'' + 1} \quad \dots\dots\dots \quad (9)$$

$$n'' = \frac{\log.\, b\,\sqrt{\frac{q}{Q}}}{\log.\, l - \log.\, y} \quad \dots\dots\dots \quad (10)$$

$$e = \frac{d}{2}\left(\frac{n' + 1}{n' + 2}\right)\sqrt{\frac{n'' + 1}{n + 2}} \quad \dots\dots\dots \quad (11)$$

$$r = \frac{(n' + 1)\,(n + 1)}{n'\,n''} \quad \dots\dots\dots \quad (12)$$

$$\delta = d\,\sqrt[r]{\frac{t}{T}} \quad \dots\dots\dots \quad (13)$$

$$t = \frac{\delta^r\,T}{d^r} \quad \dots\dots\dots \quad (14)$$

$$y = \sqrt[n]{b^n - \left(\frac{b\,x}{l}\right)^n} \text{ Ellipse} \quad \dots\dots\dots \quad (15)$$

$$l' = l\left(2\,\sqrt[n]{\frac{b - z}{b}} - \sqrt[n]{\frac{b - 2\,z}{b}}\right) \quad \dots\dots\dots \quad (16)$$

$$l = \frac{l'}{2\,\sqrt[n]{\frac{b - z}{b}} - \sqrt[n]{\frac{b - 2\,z}{b}}} \quad \dots\dots\dots \quad (17)$$

$$c = l\left(1 - \sqrt[r]{\frac{b - z}{b}}\right) \quad \dots\dots\dots \quad (18)$$

$$a = l' + c - l \quad \dots\dots\dots \quad (19)$$

$$A = 2\,\sqrt{\frac{n''}{n + 1}}\left(Q' + d'\,L\right) + a' \quad \dots\dots\dots \quad (20)$$

$$H = \frac{M^3\,Q}{k\,L} \quad \dots\dots\dots \quad (21)$$

$$M = \sqrt[3]{\frac{k\,L\,H}{Q}} \quad \dots\dots\dots \quad (22)$$

$$m = \frac{B^3}{12\,Q}\,\sqrt[3]{\frac{D}{L\,Q}} \quad \dots\dots\dots \quad (23)$$

$$m = \frac{B^3}{12\,Q}\,\sqrt[3]{\frac{n}{(n + 1)\left(1 + \frac{1}{2\,n''}\right)}} \quad \dots\dots\dots \quad (24)$$

$$n'' = \frac{\sqrt{8\,D\,(Q\,L - D) + 9\,D} - 3\,D}{4\,(Q\,L - D)} \quad \dots\dots\dots \quad (25)$$

$$e' = \frac{d'\,(d'\,L + a + Q)}{2\,d'\,L + a + 2\,Q'}\left(\frac{n' + 1}{n' + 2}\,\sqrt{\frac{n'' + 1}{n + 2}}\right) \quad \dots\dots\dots \quad (26)$$

TABLE I.

Exp. n	Ordinates and Cross Sections. 1	2	3	4	5	6	7	8	Area W L square feet. Disp. cubic feet.	Centre of gravity e. Disp. tons.	Exp. r. Coefficient k.
2	·2345	·4375	·6094	·7500	·8593	·9375	·9844	b	a = ·6666 B L	e = ·325 d	r = 2·25
	·0545	·1914	·3713	·5625	·7384	·8909	·9688	Q	D = ·5333 Q L	T = ·0152 Q L	k = 1·94
2½	·2838	·5129	·6912	·8232	·9139	·9687	·9944	b	a = ·7142 B L	e = ·343 d	r = 2·00
	·0805	·2512	·4778	·6777	·8352	·9383	·9889	Q	D = ·5952 Q L	T = ·0170 Q D	h = 2·00
3	·3301	·5781	·7558	·8750	·9472	·9844	·9980	b	a = ·7500 B L	e = ·358 d	r = 1·77
	·1090	·3312	·5713	·7667	·8972	·9691	·9960	Q	D = ·6429 Q L	T = ·0181 Q L	k = 1·94
3½	·3733	·6346	·8070	·9116	·9677	·9922	·9993	b	a = ·7777 B L	e = ·370 d	r = 1·71
	·1394	·4027	·6512	·8310	·9365	·9845	·9986	Q	D = ·6806 Q L	T = ·0194 Q L	k = 1·88
4	·4138	·6836	·8474	·9375	·9802	·9961	·9997	b	a = ·8000 B L	e = ·381 d	r = 1·56
	·1712	·4673	·7181	·8789	·9608	·9922	·9994	Q	D = ·7111 Q L	T = ·0203 Q L	k = 1·82
5	·4871	·7627	·9046	·9687	·9926	·9990	·9999	b	a = ·8333 B L	e = ·397 d	r = 1·44
	·2373	·5817	·8183	·9384	·9853	·9980	·9998	Q	D = ·7575 Q L	T = ·0216 Q L	k = 1·70
6	·5512	·8220	·9404	·9843	·9972	·9997	1·0000	b	a = ·8571 B L	e = ·409 d	r = 1·36
	·3038	·6757	·8844	·9688	·9944	·9995	·9999	Q	D = ·7924 Q L	T = ·0227 Q L	k = 1·58
8	·6564	·8989	·9767	·9960	·9996	·9999	1·0000	b	a = ·8888 B L	e = ·426 d	r = 1·26
	·4309	·8080	·9540	·9920	·9992	·9998	1·0000	Q	D = ·8366 Q L	T = ·0233 Q L	k = 1·34
10	·7369	·9437	·9909	·9990	·9999	1·0000	1·0000	b	a = ·9090 B L	e = ·458 d	r = 1·21
	·5430	·8906	·9819	·9980	·9998	·9999	1·0000	Q	D = ·8658 Q L	T = ·0248 Q L	k = 1·18

Explanation of Formulæ.

The parabolic formulæ 1 and 2 are for calculating the curvature of the load water-line and cross-section. The abscissa x, subtracted from b, gives the ordinate from the centre line of the vessel to the water-line or cross-section. Formula 3 is for finding the exponent of the water-line. Formula 4 gives the ordinate immersed cross-sections between Q and the stern or bow. In the accompanying table ordinates and cross-sections are calculated for eight places between Q and the stem or stern, numbered as shown in the table, and figures 1 and 2.

Example 1. Required the fourth ordinate of a water-line with the exponent n = 3 and b = 18 feet. See table, exponent 3, line b in the 4th column. Ordinate 0·8750 × 18 = 15·75 feet, the answer.

Example 2. Required the area of the 3rd, for the exponent n'' = 4, Q = 455 square feet. See table, exponent 4, line Q, 3rd column. q = 0·7181 × 455 = 326·7 square feet, the answer.

The exponent n need not be alike, fore and aft, but n'' must be the same, so that the area q be equal for the same number of ordinates fore and aft of Q. This rule should be carefully observed.

Example 3. Required the area of the load water-line of a vessel L = 255 feet, B = 28 feet and the exponent n = 3½ ?

$$\text{Formula 5.} \quad a = \frac{3{\cdot}5 \times 28 \times 255}{3{\cdot}5 + 1} = 5553{\cdot}3 \text{ square feet.}$$

Example 4. The greatest immersed cross-section Q = 307 square feet, B = 32 feet, and d = 12 feet. Required the exponent n' ?

$$\text{Formula 8.} \quad n' = \frac{307}{32 \times 12 - 307} = 4, \text{ the answer.}$$

Example 5. A ship of Q = 307 square feet, L = 250 feet long, and the exponent $n'' = 4$. Required the displacement D in cubic feet?

Formula 9. $D = \frac{307 \times 250 \times 32}{32 + 13} = 54577$ cubic feet.

Formula 25 is for finding the exponent n'', when Q, D and L are given.

Formula 10 is for finding the exponent n'', when Q, q, l, b, and the distance y between Q and q are given.

The formulæ 3, 6, 8, 10, and 25 will give the exponents for any vessel.

Example 6. A vessel of $d = 12$ feet draft of water (depth of keel omitted), constructed with the exponents $n = 3$, $n' = 6$ and $n'' = 3$. Required the depth of the centre of gravity of displacement under water-line?

Formula 11. $e = \frac{12}{2}\left(\frac{6+1}{6+2}\right)\sqrt{\frac{3+1}{3+2}} = 4{\cdot}695$ feet.

The centre of gravity of the displacement in the length of the vessel will always be halfway between Q and the middle of L.

Example 7. A vessel constructed with the exponents $n = 2\frac{1}{2}$, $n' = 4$ and $n'' = 2\frac{3}{4}$. The load draft of the vessel is $d = 16$ feet, when the displacement T = 4500 tons. Required her displacement t = ? at $\delta = 9$ feet draft.

Formula 12. Index $r = \frac{(4 + 1)(2{\cdot}5 + 1)}{4 \times 2{\cdot}75} = 1{\cdot}59$.

Formula 14. $t = \frac{9^{1\cdot59} \times 4500}{16^{1\cdot59}} = 1432$ tons, the answer.

The launching draft is calculated by the formula 13, when t = weight of the vessel in tons.

The formula 15 is for calculating the elliptic form of the stern-rail or deck; its nature is the same as that of the parabolic formula 1, namely, the higher the exponent is, the fuller will the line be.

Ordinates for ellipses of different orders from 2 to 4, are calculated and contained in the accompanying Table II. Half the greatest rail-beam multiplied by the tabular number, gives the corresponding ordinate in the stern-rail ellipse.

See fig. 8, where the stern-rail is an ellipse of the third order or $n = 3$.

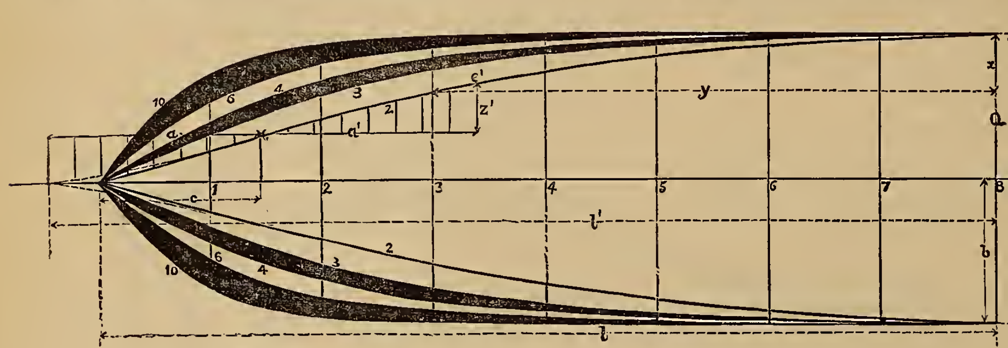


FIG. 1.

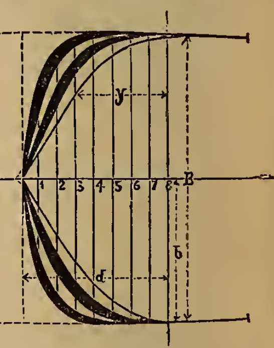


FIG. 2.

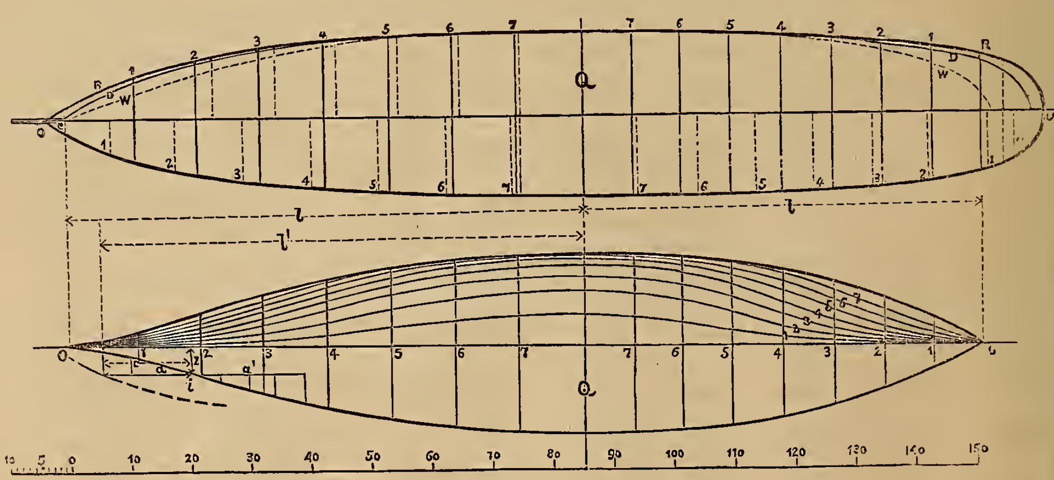


FIG. 8.

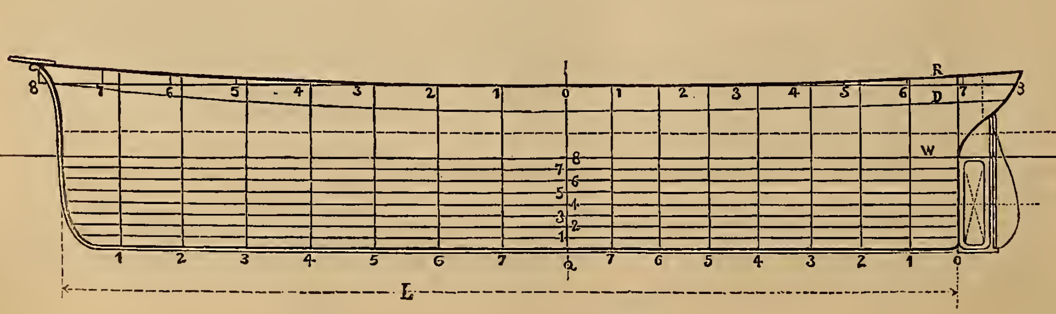


FIG. 6.

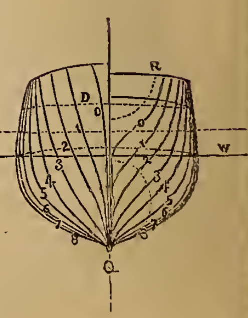


FIG. 7.

TABLE II. ELLIPTIC STERN OF VESSELS.

Exponent.		ORDINATES FOR ELLIPSES OF DIFFERENT ORDER.						
n	$\frac{1}{2}$	1	2	3	4	5	6	7
2	·3398	·4840	·6616	·7808	·8660	·9204	·9682	·9922
$2\frac{1}{4}$	·4108	·5490	·7147	·8274	·9004	·9495	·9801	·9958
$2\frac{1}{2}$	·4670	·5537	·7657	·8627	·9252	·9646	·9873	·9978
$2\frac{3}{4}$	·5174	·6514	·8029	·8901	·9434	·9749	·9932	·9989
3	·5604	·6911	·8331	·9019	·9565	·9821	·9948	·9994
$3\frac{1}{4}$	·5991	·7252	·8578	·9275	·9664	·9871	·9973	·9996
$3\frac{1}{2}$	·6333	·7548	·8782	·9406	·9740	·9907	·9978	·9998
4	·6906	·8021	·9093	·9595	·9840	·9950	·9995	·9999
Sheer	30°	·0149	·0582	·1321	·2374	·3740	·5419	·7531
of	45°	·0157	·0539	·1221	·2152	·3517	·5227	·7313
Vessels.	60°	·0160	·0474	·1086	·1972	·3190	·4794	·6946

SHEER.—The sheer lines are calculated for circle-arcs of 30°, 45°, and 60°; they will be ellipses of the second order; for 30° the elliptical form is hardly perceptible, but for 60° it is more so.

DEAD FLAT.—There is a difference of opinion among shipbuilders as to where to place the dead flat Q. Some place it forward, some abaft, and some in the middle of the vessel. It appears that on sailing vessels the dead flat should be located forward, on account of the centre of effort of the sails being high above the ship. In paddle steamers the dead flat should be located in the centre, and in propellers abaft the centre. In sailing yachts the dead flat is most generally abaft the centre.

The yacht *America*, which won the prize at the Exhibition in London in 1851, had her dead flat about three-eights from the stern. The yacht *America* is a perfect model of the parabolic construction; her exponents are $n = n' = 2$, and $n'' = 2\frac{1}{4}$, with no hollow lines.

The clipper ship *Great Republic* had her dead flat abaft the centre, and the centre of effort of her sails was about 12ft. ahead of the centre of gravity of her displacement. This is an exceptional case; in sailing vessels the dead flat is most generally placed forward of the centre.

HOLLOW LINES.—It is the fashion in our days to make the load water-line hollow fore and aft. which fancy is only pleasing and deceiving to the eye. Experiments have been made with a view to find out some less resistance to vessels with hollow lines, but have not, that I am aware of, given any satisfactory results. The hollow lines take away a good portion of the displacement, and diminish the strength and stability of the vessel. In order to follow up the fashion I will here describe how hollow lines are formed in the parabolic construction. Let i, Fig. 1, be the point where the hollow line is to commence; draw through i a line parallel to the centre line, draw the ordinate z, find $z' = z$, make $a = a'$; then e is the stem or stern of the boat. Draw equal number of ordinates on a and a', by which the line $e'\ i$ is transferred to $i\ e$, and forms the hollow part of the water-line. The ordinate z is the measure of the hollow line, and ought not to exceed $z = \frac{1}{3}\ b$. The formulæ 16, 17, 18, and 19, are for calculating different parts connected with the hollow line, as will be understood by referring to Figs. 1 and 8. Should it be desired to be very fashionable, we can even form a wave-line by the parabolas.

THE HULL OF VESSELS.—The area A of the hull of a boat will be found by the formula 20,

Example 8. A vessel constructed with the exponents $n = n'' = 4$, $Q = 307$ square feet, $d = 12$ feet, $L = 250$ feet, and the area of the water-line $a = 5600$ square feet. Required the area of the immersed portion of the hull.

Formula 20. $$A = 2\sqrt{\frac{4}{4+1}}\left(307 + 12 \times 250\right) + 5600 = 11516 \text{ sq. ft.}$$

If the vessel is to be coppered, add 15 per cent. to the area A, and it gives the surface of copper required to cover the immersed portion of the hull, including the lap.

Example 9. A vessel of the same dimensions as in the preceding example has the upper deck 8 feet above the load water-line; the beam $B = 28$ feet, makes $d' = 12 + 8 = 20$ feet, and $Q = 307 + 28 \times 8 = 531$ square feet, area of the upper deck, $a' = 6720$ square feet. Required the area of the hull from the keel to the upper deck.

$$A = 2\sqrt{\frac{4}{4+1}}\left(531 + 20 \times 250\right) + 6720 = 16{,}614 \text{ sq. feet.}$$

Example 10. Suppose the hull of the vessel in the preceding examples to be of $\frac{1}{2}$-inch plate iron, and add 15 per cent. to the area A for lap and rivets. Required the weight of the hull in tons, from the keel to the upper deck.

$$A = 16{,}614 \times 1{\cdot}15 = 19{,}106 \text{ square feet.}$$

The weight of $\frac{1}{2}$-inch iron is 20lbs. per square foot, when the weight of the hull will be

$$\frac{19.106 \times 20}{2240} = 171 \text{ tons nearly.}$$

Example 11. Suppose the distance between the frames to be 18 inches or 1·5 feet. Required the length of all the frames to the upper deck. From example 9 we have $A = 16{,}614$ square feet, when the length of the frames will be

$$\frac{16{,}614}{1{\cdot}5} = 11{,}076 \text{ feet,—the answer.}$$

Example 12. Required the depth of the centre of gravity in the hull of a vessel with dimensions, as in the preceding examples. The exponent for the cross section $n' = 10$. The bulwark and keel omitted. Length of upper deck $L = 262$ feet.

Formula 26.

$$c' = \frac{20\,(20 \times 250 + 5600 + 531)}{2 \times 20 \times 250 + 5600 + 2 \times 531}\left(\frac{10+1}{10+2}\right)\sqrt{\frac{4+1}{4+2}} = 11{\cdot}2 \text{ feet.}$$

It will be seen that the exponents perform the most prominent part, both in the calculation and construction. By proper selection of the exponents, any form of vessels can be constructed by the parabolic method.

The formula 21 is for calculating the horse-power necessary for a given speed; the co-efficient k will be found in Table I., last column, in the line of the given exponent for the displacement.

Example 13. What power is required for a vessel of dimensions as in the preceding examples to propel her $M = 9$ knots per hour? $n'' = 4$ $k = 1{\cdot}82$, $Q = 307$, and $L = 250$.

Formula 21. $$H = \frac{9^3 \times 307}{1{\cdot}82 \times 250} = 491{\cdot}8 \text{ horses.}$$

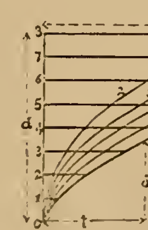


FIG. 4.

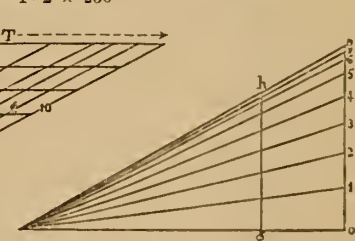


FIG. 5.

Fig. 3 is a scale of displacement at different drafts of water; it is calculated and constructed by the formulæ 13 and 14. The numbers on the curves denote the exponent n'' of the vessel, and not the index r. The displacement T is represented by the 8th water-line, from the figure 8 to where it meets the curve; all the other water-lines represent the displacement t at the noted draft.

Fig. 4 is a diagram for laying out the ordinates in the water-line and cross section; one of these should be constructed for each exponent n. This diagram is constructed with the exponent $n = 2$, the line $g\ h = b$, Figs. 1 and 2, and the ordinates in the inner parabola correspond with the distances from g in the diagram. It is constructed in the following way:—Make a right-angled triangle of any desired size; make the base longer than the height; call the height $= 1$; decide the exponent for the diagram: set off from the right angle the ordinates in the line b, Table 1., and join them with the opposite angle in the triangle; then any beam b set off at right angle from the base to the hypothenuse gives the corresponding ordinates in the water-line or cross section.

FIG. 5.

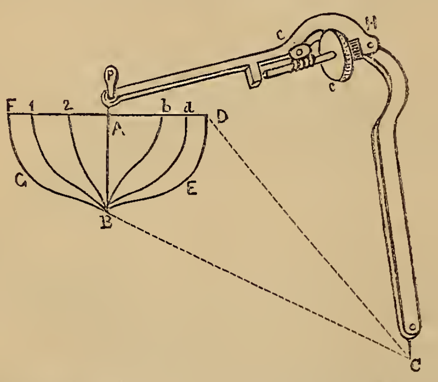
Fig. 5 shows how to lay out the spring of the beams; the length is divided into 8 equal parts from each end, numbered as shown by the figure. The spring of deck beams ought to be a parabola of the second order, when the ordinates are calculated from the line b, exponent 2, Table 1. the spring $b = 1$.

(To be continued.)

DESCRIPTION OF AMSLER'S PLANOMETER, AS APPLIED TO SHIPBUILDING.

This very ingenious and useful instrument seems to be but little known among engineers and constructors. It is a very important instrument in the construction of ships, where it saves a great deal of time and calculations; by applying the planometer to the frame drawing of a ship, the displacement is obtained correctly with only one multiplication, in a few minutes.

The accompanying figure represents Amsler's Planometer in position to take the areas of the immersed cross-sections of a ship. The instrument rests on three points, namely, A, C, and *e*; it has a hinge at H; the point C is stationary when the point P moves about; the wheel *c* turns in different directions, indicating the area described by P. The nature of the instrument is such that, when the point P moves from D via A to B, the wheel *c* indicates the area of the figure A, B, C, D; if P is moved further from B via E to D, the wheel *c* subtracts the area B, C, D, E.



leaving indicated the area A B E D. The wheel *c*, with the assistance of a *vernier*, gives three figures in the reading, and the wheel *e* moved by a worm-screw gives the fourth figure; the instrument gives a nicety of four figures in the reading, which is sufficient for most practical purposes.

The planometers are always made so that the point P is to be moved with the sun. However irregular a plan-figure might be, the point P moved through the whole boundary, gives the area on the whole *c* and *e*. The cross-section A, B, *b*, is obtained by moving P in the boundary from A via B, *b*, and back to A.

When it is desired to know the area of all the cross-sections, it is not necessary to read off every one of them, but continue to move through all the boundaries, and the wheels will add up the whole to one sum, which, multiplied by 2 and the distance between the sections, gives the displacement; though care must be taken not to take the greatest section *p* twice. Suppose all the areas of the figure before us is to be taken for the displacement: Move P from A to B *b* A, B *a* A, B E D A, further from A to 2, B A 1, B A, and the wheels will show the total sum of half the sections.

INSTITUTION OF CIVIL ENGINEERS.

STRUCTURES IN THE SEA, WITHOUT COFFER DAMS; WITH A DESCRIPTION OF WORKS OF THE NEW ALBERT HARBOURS AT GREENOCK.

By Mr. D. Miller.

It was stated that the immediate object of this Paper was to treat of the various methods of constructing the foundations of quays, walls, piers, or breakwaters, for the formation of docks and harbours, in deep water; and to describe works of this kind which have been carried out on principles different to those usually practised, and to point out the further application of those principles to other structures of a similar nature. The plans which had chiefly prevailed were, founding upon piling carried up to about the level of low water, constructing within caissons or coffer-dams, or building under water by means of diving apparatus. Instances of the failure of the first of these methods, which was believed to be inapplicable where there were marine worms, were given. The second was most effectual, but was generally expensive, and often attended with danger. The last was also costly, besides being subject to delay in the progress of the works. In bridge building, of late years, the plan of forming enclosures of close piling, of the shape of the pier, and filling in with hydraulic concrete, had been pursued by French engineers; and the substitution of iron for perishable timber piling, in the construction on this plan of the piers of the Chelsea and Westminster bridges, by Mr. Page (M.Inst.C.E.), was considered to be a successful departure from stereotyped rules.

Although the value of béton, or hydraulic concrete, was now appreciated in this country as a substitute for masonry, and had been employed in some important works, yet its use was chiefly confined to forming a homogeneous and monolithic bearing stratum for foundations, and not, properly speaking, as a constructive material. The modes in which concrete had been applied for constructive purposes were, building it dry in mass, and allowing it to set before being placed in the work, as had been adopted in the construction of the walls of the Victoria and of the London Docks; preparing it first in blocks, and allowing it to harden before being used, as employed at the Dover breakwater, and for the new sea forts at Portsmouth and Plymouth; and depositing it in a liquid state, and allowing it to set under water, as practised at the Government Graving Docks at Toulon. The facilities for making beton, which had the invaluable property of setting under water, and of thus forming an artificial rock or stone, were very great; as it might be made either from the naturally hydraulic limes, the artificially hydraulic limes, or cement, or from the rich or non-hydraulic limes, rendered hydraulic by the admixture of other substances, such as Puzzolana, minion, or iron mine-dust. Various examples were adduced of the application of concrete, on a large scale, prepared from these different materials, especially at the Mole of Algiers, at the breakwater at Marseilles, and at other French ports, as well as in the Pont d'Alma over the Seine, in which case both the arches and the piers were formed of rubble concrete.

As Engineers-in-chief for the new harbour works for the port of Greenock, the author and his partner, Mr. Bell, had an opportunity of introducing a system of constructing sea walls and quays in deep water, without the aid of coffer dams, diving apparatus, or other means equally expensive. These works were situated on the west side of the town, and had been projected almost entirely beyond the high water line into the sea. The outer pier would ultimately be upwards of 3000ft. in length and about 60ft. wide at the top, with quays on both sides. Within this there would be space for two harbours, each 1000ft. in length, 15ft. deep at low water, and 25ft. at high water, with entrances 100ft. wide, and ample room for the construction of graving docks, for the storage of timber, and for the erection of sheds. At present it was only proposed to erect about one-half of the sea pier, and to form one harbour or tidal dock. In the design of these works, it was suggested that the walls under low water should consist of a combination of cast-iron guide piles in the front, with a continuous stone facing, slid down over and enclosing these piles, timber-bearing piles being used in the body of the walls where required, aad concrete backing being deposited in a soft state; and that the upper part of the walls should be built of masonry in the usual manner. The first operation, when the water was not sufficiently deep, was to dredge two parallel trenches to the required depth, 17 feet below low water, for the foundations. A staging of timber piles was afterwards erected in the line of the pier over its whole breadth, for carrying the tramways travelling cranes, and piling engines. The cast-iron guide piles were then driven from the staging, with great precision, 7 feet apart in the line of the face of each quay wall. These piles were driven until their heads were near to the low water line, by pile engines, furnished with long arms projecting downwards, strongly stayed by diagonals, and forming a trough, into which the pile was placed, and from which it was shot, like an arrow from a cross-bow. The piles were connected at the top transversely by wrought iron tie-rods stretching through the pier. When the piling was driven, a bed of hydraulic concrete, 3 feet thick, and 20 feet wide, was deposited in the trenches to form a base for the wall, and to give a large bearing surface. Into the grooves formed by the flanges of the iron piles, large granite slabs from the Ross of Mull, from 18 inches to 2 feet thick, were slipped, the bottom one resting on the concrete base, and on a projecting web cast on the piles. This constituted the face of the wall, and in each compartment between the piles, 16 feet in height and 7 feet in width, there were only three stones. Behind this facing hydraulic concrete was lowered, under low water, in large boxes having moveable bottoms, and was discharged in mass to form the body of the wall. To confine this at the back before it had set, loose rubble stones were deposited. The hearting of the pier consisted of hard till, stones, and granite up to the level of low-water. When the whole of this mass was consolidated, the heads of the iron piles and the granite facing blocks were capped by a granite blocking or string-course, and the upper portion of the walls was built in freestone ashlar and rubble. The remainder of the hearting between the walls was then filled in, and the whole finished with a granite coping and causeway. The walls were 33ft. in height from the foundations, $11\frac{1}{2}$ feet thick at the concrete base, diminished by 5ft. at the top. In the part of the work already executed, the outer flange of the iron piles was exposed to the action of the salt water. In future it was intended to reverse this plan and to make grooves in the stone facing, so that it should over-

lap the iron piles, filling in the grooves from the top with cement. When the whole extent of the seaward pier was completed, the interior operations for the harbour would be proceeded with; this pier serving as the principal coffer dam, and a short dam, about 100ft. in length, closing the entrance. It was stated that this mode of constructing walls in deep water without coffer dams had been most successful, and that a sea-pier of great solidity and durability had been formed in deep water at a comparatively moderate cost. The works of the Albert Harbour were being executed under the superintendence of Mr. John Thompson, as resident engineer, by Messrs. W. and J. York, contractors.

The application of this system to the construction of breakwaters and harbours of refuge, was then noticed, reference being first made to the principal modes of construction hitherto adopted, and to the peculiar phenomena by which such structures were affected. The usual method of forming breakwaters was by the *pierre perdue*, or long slope system, as carried out at Plymouth, Cherbourg, and Holyhead. Where stone was most abundant, a vertical wall was built from the bottom by means of diving apparatus, of which the breakwater at Dover, now in course of construction, was the most prominent example. Besides these systems, which might be taken as the extremes, an intermediate form of section, combining both, that was to say, a rubble mound to a certain depth under low water, and a vertical wall above, had been carried out at Alderney. From an examination of the general principles which affected breakwaters, and the modes of construction usually adopted, the conclusion arrived at was, that the vertical system was that which had best resisted, or rather averted, the destructive action of the sea, and required the smallest amount of material. Both the long-slope and the vertical systems, as at present carried out, were expensive, from the quantity of material used in the one case, and the costliness of the material and the mode of construction in the other; the former might be characterised as involving the maximum in quantity, and the minimum in cost of material; the latter, on the contrary, the mimimum in qnantity and the maximum in cost of material. The object sought to be attained in the new system was to effect a minimum, as far as possible, both in the quantity and in the cost of the material. Breakwaters might be thus constructed, either wholly vertical from the bottom, or partially vertical, springing from a rubble mound. The principal feature of the new plan was a framework of iron piles, or standards, and ties, which would serve during the construction as the staging, and would afterwards form an essential portion of the structure, by binding together a strong casing of stone, or other sufficiently durable material, which would enclose and form the facing of the breakwater, the interior being filled up with loose rubble, cemented into a solid mass by liquid concrete. As soon as a pair of piles transversely had been fixed, rubble would be deposited up to, say, 18ft. under low water. Strong casing blocks, either of stone or of *béton*, made to enclose the iron standards, would then be lowered, the blocks being locked or arched into each other, so as to resist pressure from behind and made to break bond, if thought desirable. The hearting of the work would be proceeded with simultaneously with the building of the casing, and would consist of rubble in the centre, and of hydraulic concrete behind the stone casing. It was believed that such a structure could be erected in a depth of 6 fathoms, with a range of tide of 15 feet, for £190 per lineal yard, without a parapet, and at £200 per lineal yard including a parapet. The economy of this system would arise from the smallness in quantity and the cheapness of the bulk of the material. It would also possess the advantage of rapid execution, as the mass of the material could be deposited without any tedious operation being necessary over a great length of the work at one time.

The author was of opinion that the system which had been described admitted of being applied for the construction of the works under low water, of marine fortifications, as well as of breakwaters, piers, quay-walls, lighthouses, and other similar structures. He considered that, although the mode of constructing an engineering work must be determined greatly by local circumstances, this system presented the following advantages—great economy, combined with strength and durability; facility and rapidity of execution; and adaptability to situations where the present modes of construction would be inapplicable.

ROYAL INSTITUTION OF GREAT BRITAIN,

ON ARTIFICIAL ILLUMINATION.

By Edward Frankland, Esq.

Ten years ago the speaker gave in this Institution a sketch of the condition of Artificial Illumination. Since that period but little progress had been made towards perfecting those processes of producing artificial light at that time in general use. Nevertheless, the improvments effected in the production and application of the electric light, the increase of our knowledge both of solar and terrestrial light, and especially the discovery of an entirely new illuminating agent, threatening to produce a revolution in lighting almost equal to that which was the result of the invention of gas—rendered it desirable again to review this subject, after the lapse of a decade.

In glancing at the improvements effected in the different departments of artificial illumination, those which relate to the Electric Light were first noticed. The electric light is produced by the interruption of an electric current flowing through good conductors; by this interruption the current is made to leap across a space provided in its circuit. The boundaries of this space, in the ordinary electric light, are formed by two portions of gas carbon, and during the passage of the electric current across it, the two pieces of carbon are heated to a most intense degree, and far beyond that produced by any other means at our disposal. The great source of illuminating power was shown to be the ignited ends of these two pieces of gas-carbon, and not the space between them.

Such being the nature of the electric light, the principal improvment which has been effected in it during the past ten years, consists in the production of the electric current through the intervention of heat and mechanical force by what is termed magneto-electricity. More than thirty years ago, Mr. Faraday produced a spark from the ordinary permanent magnet. Here, said the speaker (producing a magnet), is the very cradle of this magneto-electric light, and this is very magnet with which Mr. Faraday operated. This improvement constitutes one of the greatest steps in advance which have been made in the application and production of the electric light. By the combustion of coal a certain amount of mechanical power is obtained, which is applied to the rotation of masses of iron in the neighbourhood of very powerful permanent magnets. In this way, currents of electricity are produced, and these are thrown together, and made to circulate through a system of conductors: in fact, there is no difference, as regards the effect at the carbon-prisms, between the action of this magneto-electric curreut, and the ordinary electric current produced by the chemical action which takes place in the voltaic battery. But this improved mode of producing the electric force demands less manual labour, the mechanical work being performed by a steam-engine, which causes the rotation of the armatures.

This magneto-electric apparatus, as perfected by Mr. Holmes, has now been in use for upwards of two years in the South Foreland and Dungeness Lighthouse, where, as well as in other similar beacons, the production of a light of the greatest intensity is of the greatest importance to the mariner. During this time it has performed its office remarkably well, and without a single instance of failure, thus proving itself well adapted for the purposes of lighthouse illumination.

For domestic light it has not been yet brought into use, its expense, doubtless, at the present moment, being far too great to admit of its being employed in this way; but where a light of great intensity, regardless almost of the question of expense, is required, as in the case of lighthouses, the magneto-electric light can scarcely be too much prized.

The speaker also described the mercurial electric light, but considered it inferior both in brilliancy and steadiness, to that procured by the passage of the electric current between carbon terminals.

The discoveries and improvments connected with gas as an illumination agent were then considered. It is of great importance that gas, as light-giving material, should be improved to the utmost possible extent, so as to make it a perfect source of light. Its conveniences are so patent to every one, its use is attended with so few discomforts, and the light is obtained with such facility, and of any desired intensity with certain limits, that there is, perhaps, no source of artificial light capable of such general application. Nevertheless, this is one of the modes of illumination which, having been long previously in use, has not made great progress during the past ten years. The sulphur compounds, which at the commencement of that time were complained of being present in purified gas, are still there in considerable, if not in undiminished quantity, although there has recently been a process devised by means of which these impurities can be, to a great extent, got rid of. It remains to be seen whether this process be applicable, on a large scale, in the gas manufactory; but, so far as can be judged from experiments made upon a small scale, it is a process which is likely to be very effective. It is the invention of the Rev. Mr. Bowditch, of Wakefield. These sulphur compounds are irremovable in the ordinary process of purification. The gas may be passed in the usual manner over hydrate of lime, or the peroxide of iron; but this operation does not, in the slightest degree, affect the sulphur compounds in question; during the combustion of the gas, however, their sulphur is converted into sulphurous acid, which diffuses itself into the apartment in which the gas is burned, and a great deal of the discomfort of which many complain in the use of gas is due to this cause. Mr. Bowditch discovered that though cold hydrate of lime will not remove impurities, they are to a great extent got rid of by heating the hydrate of lime to a temperature varying from the boiling point of water up to 400° or 500° Fahr., a temperature of 400° being the most convenient for the development of the effects of his process. The heated hydrate of lime converts the sulphur compounds into sulphuretted hydrogen and carbonic acid, which can then be removed by the ordinary purifying material—cold hy-

drate of lime. This process has been found by repeated experiments to remove all but about 2 or 3 grains of sulphur per 100 cubic feet of gas, the quantity of sulphur originally contained in the gas varying from 5 or 6 grains up to 20 grains in 100 cubic feet. Heated hydrate of lime was shown to develope sulphuretted hydrogen from the gas supplied to the Institution.

Another recently ascertained fact in connection with gas is the discovery of an illuminating constituent recently made by M. Berthelot. This is a gaseous body, called Acetylene, which is produced under very peculiar circumstances. Unlike all other hydrocarbons with which we were formerly acquainted, an intense heat is favourable to the production of this body. For instance, it is produced when coke is very intensely ignited in hydrogen gas; and Dr. Odling has recently demonstrated that two of the constituents of coal-gas, light carburetted hydrogen and carbonic oxide, which are useless for lighting purposes, may, by means of strong ignition, be made to form acetylene, and thus become luminiferous agents. It has generally been considered important to preserve a moderate degree of heat in gas-making, in order to prevent the destruction of the luminiferous hydrocarbons; but the discovery of the formation of acetylene, under the circumstances named, will render it necessary to investigate how far the production of this substance can be carried on upon a large scale, and rendered valuable for increasing the illuminating power of gas. The subject is yet in embryo, but it has an important bearing upon the future progress of gas-lighting. Acetylene and olefiant gas contain, in equal volumes, the same amount of carbon, but the former contains only half as much hydrogen as the latter; consequently, the illuminating power of acetylene is probably at least double that of olefiant gas.

The compound of acetylene with copper, is a substance not altogether devoid of interest to the gas-manufacturer. When it attains a certain heat, it explodes with considerable violence, and the same effect may be produced by friction. It has been demonstrated recently, that acetylene, of copper can be produced by the passage of ordinary coal-gas, containing as it does, a trace of ammonia, through copper or brass tubes; and explosions which have taken place through cleaning out such tubes, resulting in serious injury to workmen, have been doubtless due to the presence of this substance. It is of course obvious that an explosion of this kind, even if slight in itself, may be communicated to explosive mixtures of gas and air (in a gas-holder or gas-meter, for instance), and may thus lead to very disastrous results. An explosion of this kind occurred a few years ago in Lancashire. A large meter had been detached and brought into the open air; a workman was unscrewing one of the brass connections, when the meter exploded with a loud report. The explosion could not be accounted for, as all the eye-witnesses were positive that no ignited body of any kind was near the meter.

The improvements effected in the production and application of oils for illuminating purposes were next referred to.

The animal and vegetable oils, which for ages have been employed for this purpose, have received no development of importance during the last ten years. On the other hand, new sources of this class of illuminants have been discovered, which threaten to produce a great revolution in the modes of obtaining artificial light.

One of the most important of the materials manufactured from these sources is paraffin-oil, the production of which from bog coal has been carried out on an immense scale with great ingenuity and success by Mr. Young, of Bathgate, near Edinburgh.

This new source of light is, however, already threatened by a formidable rival—native coal oil—which has been distilled by nature herself, and consequently does not require those preliminary processes which oil produced from bituminous coal has to undergo. These discoveries have been made principally in the United States of America, and more especially in Canada. In the latter country alone no less than twenty millions of gallons of this oil have been obtained from wells, several of which are spouting-wells. From these the oil rises, probably from the pressure of gas, to a considerable height above the surface of the ground, so as not to require pumping. The twenty millions of gallons, which represent the annual productions of the Canadian wells, may, upon a moderate calculation, be said to furnish, in refined oil alone, illuminating material equal to one hundred and eighty millions of pounds of sperm candles.

The importance of such a vast amount of illuminating material so cheaply obtained can scarcely be overrated in connexion with the question of the production of artificial light. Up to the present time, the refined oil from this crude petroleum has been prevented from coming into effective competition with the original paraffin-oil, owing to the carelessness with which the former has been manufactured. There is a considerable portion of light naphtha left in this oil, which renders it capable of forming explosive mixtures in the lamps wherein it is burned. Both these American oils require to be still further freed from volatile naphtha; they would then form valuable illuminating materials.

The speaker then directed attention to the following tables. The first contains the results of his experiments on the illuminating effect of these oils in connection with that of some other materials used for giving artificial light:—

Illuminating Equivalents, or the Quantities of different Illuminating Materials necessary to produce the same amount of Light.

Young's Paraffin oil	1 gallon.
American rock oil, No. 1	1·26 „
„ No. 2	1·30 „
Paraffin candles	18·6 lbs.
Sperm „	22·9 „
Wax „	26·4 „
Stearic „	27·6 „
Composite „	29·5 „
Tallow „	36 „

From this table was made the following calculation of the comparative cost, from different sources, of the light of twenty spermaceti candles, each burning for ten hours, at the rate of 120 grains per hour:—

	s.	d.
Wax	7	2½
Spermaceti	6	8
Tallow	2	8
Sperm oil	1	10
Coal gas	0	4¼
Cannel gas	0	3
Paraffin	3	10
Paraffin oil	0	5
Rock oil	0	6½

Thus, from an economical point of view, the rock-oil and the paraffin-oil approach gas much more closely than any other illuminating agent hitherto invented, while the enormous quantities in which these oils are now being produced, cannot fail to make them still lower in price. They may consequently be regarded as very formidable rivals of gas-light.

The following table contains the carbonic acid and heat generated per hour by various illuminating agents, each giving the light of twenty sperm candles:—

	Carbonic acid. cubic feet.	Heat.
Tallow	10·1	100
Spermaceti / Wax	8·3	12.
Paraffin	6·7	66
Coal gas	5·0	47
Cannel gas	4·0	32
Paraffin oil / Rock oil	3·0	29

This table shows to what extent the atmosphere of rooms is deteriorated by these illuminating agents. It shows also that, from this point of view, paraffin and rock-oils stand out as the best sources of light.

The chemical and physical laws upon which all modes of artificial illumination depend were then referred to. Every method of artificial illumination depends upon the heating of certain bodies to such a temperature that they become incandescent. With gases this temperature is much higher than liquids and solids. There is only one instance in which the incandescence of vapour is used, and that is the mercurial electric light, already alluded to. In all other cases the incandescence of solid bodies is employed. In the ordinary method of obtaining the electric light, the incandescence of solid prisms of carbon is the source of luminosity. In gas and oil flames, it is the incandescence of little particles of carbon, and in all these cases the light is produced from solid matter. The luminosity of any flame depends, first, upon the number of solid particles which exist in it at any given moment; and, secondly, upon the temperature of the flame. The number of solid particles is dependent upon the nature of the flame itself, whether it be a flame produced by the burning of bodies rich in hydrocarbons, or by the burning of bodies which are poorer in this respect. Such a flame is always affected by the pressure of the atmosphere; the higher the pressure of the air, the greater the number of luminous particles of carbon present at one time in the flame. If, after the barometer has been standing at 30 inches, it falls to 29 inches, the light of all flames is reduced to the extent of about 5 per cent. The temperature, upon which the luminosity of a flame also depends, may be increased by heating both the gas and the air supplied to it for combustion, before they are brought together to be burned.

The speaker exhibited a gas lamp which he had constructed to effect this object. It consisted of an ordinary argand burner, with glass chimney, but furnished with an outer glass cylinder resting upon a solid plate of glass, through the centre of which the tube supplying the gas ascended. Thus all the air supplied to the flame was compelled to pass down between the chimney and outer cylinder, becoming thereby strongly heated before it reached the flame, whilst considerable heat was also imparted to the gas before the latter issued from the burner. In this manner a great increase of light, with the same consumption of gas, was obtained.

The following table was exhibited, showing the effect of this hot air gas-burner in reducing the consumption of gas for a given amount of light, and thereby also the impurities and heat which are thrown into the atmosphere in which such a lamp is burned

	Rate of consumption per hour.	Illuminating power.
Argand burner supplied with cold air	3·3 cubic feet	13 sperm candles.
	3·7 „	15·5 „
	4·2 „	17 „
Same burner supplied with hot air ...	2·2 „	13 „
	2·6 „	15·5 „
	2·7 „	16·7 „
	3·0 „	19·7 „
	3·3 „	21·7 „

For an equal amount of light, the saving of gas = 33 per cent. For an equal consumption of gas, the gain in light = 62 per cent.

The temperature necessary to render substances incandescent may be imparted to them in various ways. It may be given directly by mechanical power, as in the "steel mills," formerly used in coal-mines. Usually however, chemical action is employed, as in gas, candle, and oil-flames; or electricity is used, as in the various forms of electric light.

The conditions necessary for a good and satisfactory artificial light were now examined. In the first place, the light should contain all colours; that is, it should be capable of showing every variety of tint which will be exposed to it. This is the case with the carbon electric light, and that of candle, oil, and gas flames, since the light from these sources contains all the colours of the spectrum. But there are many colours which the mercurial electric light is incapable of showing, since they are absent from its spectrum. It was also shown that all pure colours, except yellow, were perfectly black, when seen by the light of incandescent sodium vapour.

Solar light, although in so many respects superior to artificial light, is defective as regards the showing of colours. There are certain colours which cannot be seen by solar light—for instance, all the colour which can seen by the sodium flame is quite invisible in daylight. If a pigment could be made of such a yellow colour as to be of exactly the shade of that produced by the same sodium flame, it would be absolutely black in solar light. But our pigments are all mixed colours and no such pigment which thus entirely disappears in the light of the sun is known. But in addition to this tint of the sodium flame, there are hundreds of other tints which are also not present in the solar spectrum, and which are consequently invisible in daylight.

Although solar light is inferior to artificial light in the completeness of its colours, yet, in another respect—in the comparatively small amount of heat which accompanies its rays in proportion to the light itself—it is greatly supperior to every sort of artificial light. The great amount of heat in our artificial lights is absolutely useless. It is nearly all intercepted by the humours of the eye before it reach the retina, and, no doubt, produces that irksomeness which is felt after working in artificial light for any considerable time, and which is not experienced from daylight.

The speaker concluded as follows:—The history of artificial illumination cannot fail to impress upon us the difficulties in the way of the application of scientific discovery to the utilities of life. How long was it after the discovery of the production of gas from coal, before a manufacturer could be found to bring it into actual operation? Thirty years ago, working in his laboratory at Blansko, Reichenbach showed us the process by which we could obtain parallin and paraffin-oil from bituminous coal; but the discovery remained unheeded for twenty years. More than thirty years ago, Mr Faraday pointed out a source of the electric light in the permanent magnet; but we are only now beginning to use it for illuminating purposes. The brilliant little spark was long looked upon as a mere scientific curiosity, and is only now beginning to flash across the sea, guiding the mariner safely into harbour, or warning him from approaching a dangerous coast. How long will thermo-electricity have to wait before it receives a similar application? In thermo-electricity we have a direct transformation of the force of heat, which we obtain with such great economy from coal, into an electric current, and this, by further education and development, might be rendered available in the production of the electric light. Hitherto, its application in this direction has been altogether unheeded, and yet, of all sources of power necessary for the electric light, thermo-electricity evokes this power most directly from coal. In the magneto electric light we have the great disadvantage, that the heat of burning coal must be first transformed into mechanical power, which is made to rotate the armatures of magnets, and thus produce the necessary electric current. In this transformation of heat into mechanical power there is no less than 9-10ths of the original force in the coal absolutely lost. Hence the advantage which would result from the direct application of heat to the production of the electric current.

The man of science rejoices in the discovery of truth for its own sake. He give his results freely to the world. It is no part of his duty, it is not his function, to apply those truths to the utilities of life. Success in this direction demands quite different powers of mind. Those who possess these powers ought also to acquire the necessary knowledge which would enable them, with more facility, to seize upon the discoveries of science, and apply them to the wants of every-day life. This scientific knowledge is the link which, up to the present time, has so sadly failed in the application of science to the manufacturing arts.

ON FOGS AND FOG SIGNALS.

By John Hall Gladstone, Esq., Ph.D., F.R.S.

During the course of the inquiry made by the Royal Commission on Lights, Buoys, and Beacons, the attention of my colleagues and myself was called to the fog signals which form part of the apparatus of many lighthouses, and of all British light-ships. In the report we expressed our conviction, "that they are not sufficiently powerful, and recommend the provision of a more efficient warning in fog as subject of investigation and experiment." About the same time, some scientific men in Ireland stirred in the matter, and induced the British Association to appoint a committee, at the head of which is the Rev. Dr. Robinson, of Armagh, to bring the importance of the subject more directly under the notice of the legislature. These circumstances led me to turn my attention to fog; and I propose now to lay before you some of the results arrived at, with reference both to the meteorological phenomenon itself, and to the means adopted for preventing its disastrous consequences among the vessels that sail along our shores.

I have received voluminous returns of the occurrence of fog at about 250 stations, for which I am indebted to the kindness of the three general Lighthouse Boards,—the Trinity House, the Northern Commissioners of Lighthouses, and the Ballast Board of Dublin; also to the Board of Trade, through Admiral Fitz-Roy; and to Mr. Glaisher. I wish here also to express my thanks to several gentlemen who have aided me in the preparation of this discourse, especially Mr. Alexander Cuningham, who has just read a paper on the subject at the Royal Scottish Society of Arts, and to our friend Professor Wheatstone.

Fogs.

A fog is simply a cloud resting on the earth. In the first discourse of the present season, Professor Tyndall explained the formation of clouds from the aqueous vapour in the atmosphere; and defined a cumulus as "the visible capital of an invisible column of saturated air." A fog is the capital without the column. It is the moisture evaporating from the warm earth, or river, or sea, condensed at once by the colder air. Mr. Glaisher told us here how, from his lofty position in the balloon, he saw a fog following all the windings of the Thames. This is a frequent observation, and it reminded me of a scene from the summit of the Righi one morning last summer. There lay in the valley of the Reuss a mist like a white sheet on the ground, but as the sun began to exert his power, and a light breeze to spring up, the uniform layer began to break into regular masses, and soon far beneath us there stretched a cirrus cloud, identical in aspect with those we so often see in the highest regions of the atmosphere.

Fog, then, is composed of minute particles of water, most likely in a globular form, for there seems to be no ground for the popular notion of vesicles of vapour. Smoke enters largely into the composition of that peculiar yellow fog which visits London a few times each year,—a fog of wonderful darkness and quietness, and strangely bewildering.

This condensed vapour has a great effect in obstructing the passage of light; the sun himself cannot look through it. A slight mist seems to attack principally the more refrangible rays of the spectrum, so that the light appears redder than usual. I once analysed with a spectroscope the rays which reached Worthing from the great revolving light on Beachy Head, twenty-eight miles distant, and found that those only situated between Fraunhofer's lines C and F were transmitted. This was on what would be called a clear summer night. An objection has been raised against the orange-red glass used in many of the French lighthouses, that in misty weather all bright lights are reduced to very nearly that colour, and thus the distinction is lost; a misfortune that could hardly happen with the deep-red glass employed for the red lights of the British Isles. When the sun shines through a cloud or mist, we do not detect those atmospheric lines which make their appearance when his disc is near the horizon. Yet I have observed in London, when the sun at a considerable altitude loomed red through a slight fog, that the characteristic C G, δ, and η were visible.

There is, of course, every conceivable gradation between the lightest haze and the densest fog, and it is a difficult matter to draw a line of distinction between fog and mist. The value of the meteorological returns in my possession depends greatly on this, and there is reason to fear, even from internal evidence, that one lighthouse keeper calls by the name of fog what another keeper thinks sufficiently described as mist or haze. Yet these keepers have a certain general sentiment and similarity in their way of thinking, and with many the practical definition of a fog is when it is necessary to sound the signal. Among amateur observers on land the greatest discrepancy prevails; but nautical men seem to have a general agreement as to what amount of thickness is to give a claim to the designation fog. For such observations Mr. Cuningham suggests that a pole, painted vermilion, should be set up at a hundred yards from the station, and that such an amount of mistiness as renders it invisible should alone be named fog. The colour of the pole should, of course, be in strong contrast to the objects behind it. This definition is somewhere about that practically adopted by seamen; it has been accepted by Mr. Glaisher, and it is to be hoped that it will be generally adopted by all observers.

From the returns received, the following deductions may be drawn:—

1. While many fogs are quite partial in their character, others cover a large extent of country. The irregular distribution of a London fog is a matter of frequent observation. Thus, on Tuesday, the day of the royal wedding, one of the densest yellow fogs obscured Westminster, while at Bayswater there was nothing more than a murky mist. The long-continued fog of November last in London, extending from the 19th to the 25th, was observed also at Berkhampstead, Oxford, and Banbury, but other parts of England seem to have been clear. The occurrence of fog at the lighthouse stations all round the coast during the first six months of the year 1861 has been especially studied, and the fogs of that April have been represented on a map. Some of them cover large portions of the British Isles. For instance, that of the 14th stretched all round Ireland,

except the south-west corner, crossed the Irish Sea to the headlands of Wales and the south-western isles and coasts of Scotland, and made its appearance again across the mainland in the Firth of Forth.

2. Some months are marked by fogs much more than others. For instance, along the south coast of England, February and September are comparatively free, while January and June are foggy months. November is notorious for fog in London, but does not seem to deserve that character elsewhere.

3. Some years are much more visited by fogs than others. For instance, 1861 was freer than 1858 along most parts of the coast.

4. Different localities are very variously visited by fog. England does not deserve that pre-eminent character for mistiness which is attributed to it by the popular imagination of the Continent. The value of the returns in showing the relative distribution of fog in different places is seriously affected by the different standards in the minds of the observers, but the following points seem pretty clearly made out:—A fog is more uniformly distributed over the surface of the sea than on the adjoining coasts. Fog is not particularly prevalent about sand-banks, or low headlands; but where cliffs or high hills catch the south-west wind just after it has swept the ocean, as at the Isle of Wight, the Start Point, Lundy Island, and the Rocks of Pembrokeshire, the numbers run very high. The highest return is from Barra Head, the southernmost point of the Hebrides, where winds surcharged with moisture from the Gulf Stream strike the cold northern rocks, and wrap them in cloud or fog.

Fog Signals.

As light only very imperfectly penetrates a fog, attempts have been made to warn vessels of their approach to danger, or to acquaint them with their position, by means of sound. The fog signals actually in use are as follows:—Bells are employed at many of the lighthouses, and in the Irish light-ships, the finest, perhaps, being two near Dublin, and that at the Copeland Island, in the Irish sea, which is rung by machinery, and is said to have been heard thirteen miles off. At the end of the pier at Boulogne there is a large bell, in the centre of a large parabolic reflector facing the sea. It is struck by three hammers alternately, the motive power being a falling weight. Gongs are made use of in all the light-vessels belonging to the Trinity House. Guns are fired on board the *Kish* light-ship, from the mountain above the South Stack Lighthouse, at Fleetwood, and elsewhere. A very powerful steam-whistle has for some time been in operation at Partridge Island, near St. John's, New Brunswick, a part of the world peculiarly affected by fog.

At the Skerries, near Holyhead, terns and other sea-birds are encouraged, as their cries serve as a warning to vessels during fog; but unfortunately some rats escaped from the *Regulus*, which was wrecked there about seven years ago, and they are destroying the birds. A cat has been tried, but she preferred birds to rats.

The comparative efficiency of these various methods is a very serious question; indeed, there are grave objections to the use of sound at all as a fog signal. The difficulties are as follows:—A sound indicates the proximity, but not the exact direction, of a danger. In this respect it is totally different from a light. Yet the mere warning is something; and probably a suitable ear-trumpet would give a better idea of the direction than is obtained without it. There is evidence that vessels have sometimes steered by a sound; for instance,—"In the winter of 1860, the steamer *Iron Duke* having been drawn by the flood tide to the northward past Howth, was attracted by the sound of the bell, and steered by it safely towards Kingston, until the bell on the east pier of that harbour told her of her proximity, and ultimately led her into safety." The Royal Commissioners on Lights made special inquiry about the Boulogne bell, and found that some of the captains of steamers frequenting that port could find their way in by the sound of the bell, in thick weather; at least, in conjunction with the use of the lead.

An objection to the use of most of these fog signals is the fear that they may be mistaken for other sounds, or other sounds mistaken for them. Bells are frequently being rung on shipboard; the firing of guns is the well-known sign of distress; and steamers in a fog are in the habit of whistling as they go along. Gongs do not seem open to this objection; and in the case of other sounds, it might be obviated by having a definite system of repetition, as is done with the flashing and revolving lights. My friend, the Rev. T. Pelham Dale,* has indeed suggested a means of signalling, in which musical notes are employed.

Another difficulty is, that even loud sounds cannot be heard far to windward if a breeze is blowing; but this is of less importance, as a fog usually occurs in calm weather.

But the great objection to sound as a fog signal is, that a fog stops the waves of sound as it does those of light. It is well known that sound will not traverse a heterogenious medium, such as air loaded with mist. As to the fact of such signals being rendered inefficient by the very thing which they are intended to penetrate, the testimony of mariners is somewhat conflicting. Mr. Alexander Cuningham, who is the secretary of the Northern Commissioners of Lighthouses, says:—"Many years ago, having landed from the lighthouse tender on the small skerry in the Portland Firth, a fog came on. We hurried off in the hope of reaching the vessel; but before doing so, the fog shut her completely from our view. We pulled in the direction (having a compass) in which the tender was last seen; but those who know the variety and rapidity of the tides in that dangerous locality will easily be prepared to hear that our efforts were unsuccessful. We lay about the spot for some time, firing our fowling-pieces, and at last pulled for the shore. Next morning the vessel came in sight; and on comparing notes, we found that we must have been within a very short distance of her; and they had been firing small six-pound carronades all night, and we never heard them, nor did those on board hear our guns."

Yet, on the other hand, we have accounts of bells being heard at a distance of some miles during a fog, and the steam-whistle near St. John's is said by the captains and pilots of steamers frequenting that port to be most serviceable, and to be generally heard for four or six miles during strong breezes blowing on shore. It is, indeed, quite possible that fogs of the same intensity may still have a very different effect upon the same signal, and that for two reasons; first, one fog may reach far up into the atmosphere, presenting a high wall to every vibration; while another may be a thick layer lying on the surface of the earth, with an open space above, through which the swelling waves of sound may freely pass. Secondly, air perfectly saturated with moisture is no bad conductor of sound; a fog under such atmospheric conditions may therefore be far less obstructive than when the medium is more heterogeneous.

Considering these objections to the use of sound as a fog signal, must we abandon it altogether? We cannot do so, as we have nothing better to substitute. We fall back upon the recommendation of the Royal Commission, that further experiments should be made, which it is hoped will be gradually adopted by the authorities, as the majority of the other scientific recommendations have been.

Experiments should be performed on the manner and degree in which fog absorbs or destroys sounds of different pitch, or of different characters,—for instance, a sharp sound or a prolonged sound; on the various means of producing loud sounds, as to their pitch, volume, convenience, costliness, &c.; whether a repetition of the same sound, or some variation in note, octave, frequency, &c., be desirable; on the influence exerted by the height above the sea at which the sound originates; on the influence of a background, such as a tower, cliff, or hill, in reflecting the sound, or of a concave mirror; on the best means of directing a sound to a particular azimuth, or of determining its direction when on board ship.

Captains Close and Nisbet, of the Trinity Board, have made some experiments on one of these points at Holyhead Mountain, where a gun was fired from near the surface of the sea, and another at a considerable height, and the respective reports were listened to from various distances at sea. They found the upper gun was heard best for six miles, after which it lost its superiority. But the most remarkable result was the irregularity of the noise from the lower gun, which, at certain points, in fact, was not heard at all, though the flash was distinctly seen.

Powerful means of producing sound, besides those already mentioned, have been suggested. Mr. Cowper has planned a large steam-trumpet for lighthouse stations, which may be made to revolve. There is something similar in America worked by Ericsson's engine, with which is associated the name of Mr. Daboll. And Professor Holmes, of the Magneto-Electric Light, has also a steam-trumpet, which can be adapted for different notes, and gives a buzzing sound of wonderful intensity. Suggestions on this point were also made to the Royal Commissioners by several scientific men. Thus, horns were strongly recommended by more than one; but Mr. Mallet prefers explosive sounds; and Sir John Herschel says:—"It would be worth trial, what would be the effect of a battery of whistles, blown by high-pressure steam, or by a combination of three, or several sets of three, pitched exactly to harmonic intervals (key-note, third, fifth, and octave), but all of a very high pitch, and with a rattle (analogous to the pea in a common whistle), which intensifies the action on the auditory nerve." Captain Ryder believes a gun might be constructed to produce the very distinctive sound of an explosion, followed instantaneously by a whistle.

There is another and very promising field for experiment, the transmission of sound through the water itself. The experiments of M. Colladon on the Lake of Geneva proved the great distance to which sound is transmitted through water, and the velocity and directness of its course.*

In his observations he employed a bell, let down into the water; but this is a bad instrument for signalling, as its vibrations are almost instantly stopped. Many arrangements would appear to be preferable. The Syren, which was so called by its inventer, M. Cagniard de la Tour, because it would sing under water, is well adapted to give any note that is found desirable.† Long glass tubes, vibrating longitudinally, are said to produce immense volumes of sound in water: and other means might be devised. As the sound remains in the water, it would be necessary to make some communication between it and the ear of the listener. M. Colladon employed an apparatus like a spoon, with a tube for handle. By this means a mariner might listen for signals made at any important station, such as the Lizard Point, and might not only hear them at a great distance, but determine approximately their direction, unaffected by the state of the atmosphere above.

THE LONDON ASSOCIATION OF FOREMEN ENGINEERS.

On the evening of Saturday, the 14th of March, the tenth anniversary of the formation of the above-named society was celebrated by a dinner at the Bay Tree Tavern, St. Swithen's-lane, City. Mr. Keyte, of the firm of Messrs. Shears and Sons, of Bankside, presided on the occasion, and about sixty members and friends of the association were present. It had been determined some months previously to present to the President a testimonial in recognition of the services he had for many years past gratuitously rendered to the society, and the celebration of the anniversary was considered the most appropriate time for the ceremony. Mr. Joseph Newton, who for the last five years has occupied the honourable post named, was accordingly the principal guest at the dinner. After the usual loyal and patriotic toasts has been duly proposed and responded to, and that of "Prosperity to the Association" had been given by the chairman of the evening, Mr. Keyte proceeded to present to Mr. Newton the testimonial. This consisted of several articles of plate, the principal of which were a salver of considerable dimensions, an inkstand of chaste design, a goblet, and a liqueur stand. In very complimentary terms these were formally presented to the President by Mr. Keyte, who concluded his remarks by proposing the health of the recipient, which was heartily responded to.

* "Marryatt's Signals," ed. 1856.

* Mémoires de l'Academie des Sciences: Des Savans Etrangers.—Tome v.

† Ann. Chim. Phys. xii., page 171.

UNITED STATES GUN BOATS.

As a great deal has been said about the gun-boat flotilla of the United States, we herewith give for the information of our readers three views of one of these vessels, showing the general arrangement of the boilers and machinery.

Our illustrations are taken from the plans furnished by the United States Navy Department to the several shipbuilders and engineers, who were called upon to send in estimates. Fig. 1 being a tranverse section of portion of the hull, Fig. 2 a longitudinal section, and Fig. 3 being a part plan, Fig. 1 being drawn to an enlarged scale. We regret and are surprised to find that such a very objectionable form of boiler should have been selected for this purpose. We allude more especially to the height of the top of boiler above the water line. This will be apparent to the most inexperienced person, on reference to figs. 1 and 2.

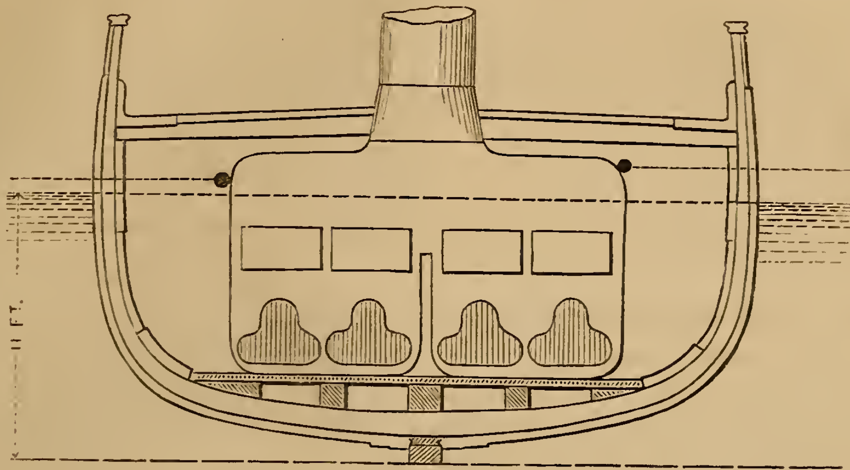


Fig. 1.

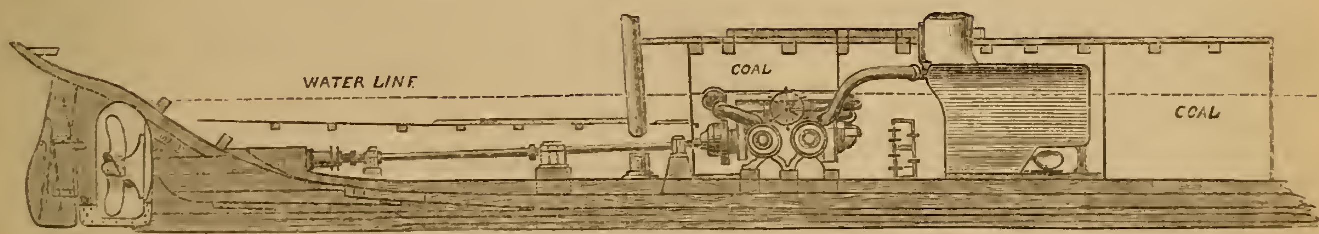


Fig. 2.

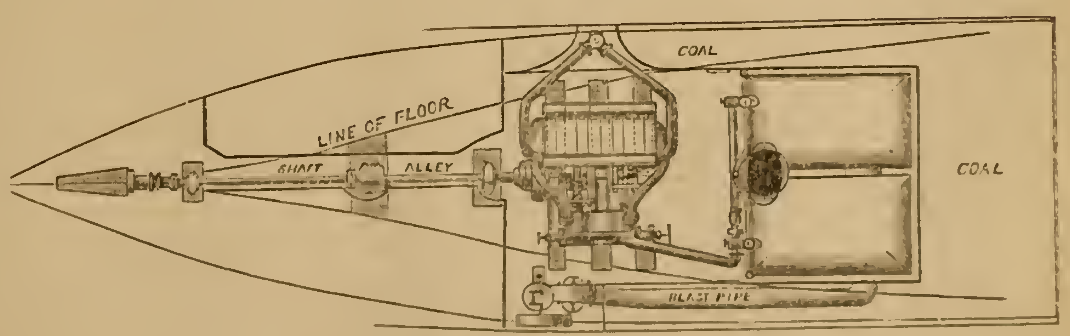


Fig. 3.

TRIAL OF THE IRON-CLAD FRIGATE, "PRINZ EUGEN" (AUSTRIAN NAVY.)

We learn from the *Triester Zeitung* that on the 25th of March the iron-clad frigate *Prinz Eugen* underwent a 12 hours' trial, with a view to test the working of the engines, which had been supplied by the Trieste Technical Establishment. A trip was made from Pola to the Muggia Bay and back. The engines are a fac-simile of those working on board the iron-clad frigates *Kaiser Max* and *Don Juan d'Austria*, supplied by the same establishment. The following are the chief particulars as to dimensions, &c., of the engines, viz.:—Nominal horse-power, 650; cylinders 74in. diameter; stroke, 39in. There are 6 tubular boilers, each of them having 5 furnaces; the aggregate heating surface is 13,000 square feet.

The working of the engines was highly satisfactory. The greatest indicated horse-power, computed from diagrams most carefully taken during the trip, is 2838 horse-power, *i.e.*, 4·4 times the nominal power. The average number of revolutions was 53, the maximum, 57 per minute, at which speed the engines worked without interruption during several hours, without any apparent sign of straining of the parts, thus bearing evidence to their excellent workmanship and their correct proportions. The average speed of the frigate during the whole trial of 12 hours, was computed at 12 nautical miles per hour. From the Muggia Bay to the entrance of the harbour of Pola she took only 5 hours, and a length of 4·75 nautical miles, viz., from Pirans to the Salvore Lighthouse was done in 22 minutes, being a speed of nearly 13 nautical miles per hour, the indicated horse-power of these engines being 4 times the nominal horse-power.

The iron-clad frigates of the Austrian Navy were designed by and erected under the superintendence of the I. R. Chief Engineer, Herr Romako, and reflect considerable credit upon him as a naval architect. The following is a return of the engines built for the Austrian Government at the Trieste Technical Establishment during the last eleven years.

	Pairs of Engines.	H.P.	
1851-57	1	100	for I.R. steamship *Taurus*.
"	1	40	for I.R. steamship *Alnoch*.
"	1	180	for I.R. steamship *Prinz Eugen*.
"	1	300	for I.R. frigate *Donau*.
"	2	230	for I.R. corvettes *Dandalo* and *Erzherzog Friedrich*.
1858	1	800	for I.R. line-of-battle ship *Kaiser*.
1859	3	50	for I.R. gunboat for the *Lagunes*.
1860	3	90	for I.R. gunboats *Kerka, Narenta, Sansego*.
"	6	90	for I.R. gunboat for the *Gardu Lake*.
1861	2	90	for I.R. gunboat *Gemse and Grille*.
"	2	500	for I.R. iron-clads *Drache* and *Salamander*.
"	1	500	for I.R. frigate *Novara*.
1862	3	650	for iron-clads *Kaiser Max, Prinz Eugen*, and *Don Juan d'Austria*.
	—	——	
	27	6470	Total horse-power.

THE THAMES EMBANKMENT.

In a report to the Metropolitan Board of Works, Mr. Bazalgette says,—"The total length of the embankment is about 7000 feet, but it is completely divided by the bridges into three sections, each of which will be viewed by itself, and the line of vision will not ordinarily be continued from one section to the other. The first section is from Westminster to Hungerford Bridge, the second from Hungerford Bridge to Waterloo, and the third from Waterloo to Blackfriars Bridge.

"A continuous line of embankment wall would not in itself be productive of much architectural effect: the present landing-places for steamboats are exceedingly ugly, and there would be much difficulty in connecting the river wall with the existing bridges, so as to produce an effective and consistent design.

"At each of the bridges there are, and must be, landing-places for steamers; and midway between the bridges there are landing-places of some description, which will have to be maintained.

"To meet these requirements, it is proposed to treat each length of embankment from bridge to bridge as a complete design, and to make the steamboat-piers and landing-places prominent and effective, as well as useful and necessary features.

"At Westminster Bridge, the roadway, which rises at an inclination of 1 in 80 to the level of the bridge, is set back some 30 or 40 feet from the face of the embankment wall; and the intervening space would be preserved as a promenade and steam-boat pier, having access from the bridge by a wide and imposing flight of steps opposite the Houses of Parliament. This will terminate without abruptness the varying styles of architecture at this point. Between Westminster and Hungerford Bridges would be the landing-stairs for small craft; and here it is proposed to introduce the beautiful water-gate now situate at the end of Buckingham-street, and erected after a design of Inigo Jones. On either side of Hungerford and Waterloo Bridges would be steamboat landing-piers, the dummies for which would be partly concealed within recesses formed by projecting into the river, in front of the general line of embankment, massive granite piers with moulded pedestals rising about 30ft. above the roadway, and hereafter to be enriched with bas-reliefs and surmounted by groups of statuary.

"Half way between Hungerford and Waterloo bridges it is proposed to construct a flight of landing steps 60ft. wide, projecting into the river, and flanked at each end with massive piers, rising to the level of a few feet above the roadway, and hereafter to be surmounted with colossal figures of river deities, or other appropriate groups. It is proposed to form an approach for foot passengers from the high level roadway to the river by a second flight of steps, descending to the level of the lower or embankment roadway, which would add much to the effect of this central feature as viewed from the river. On either side of this approach, a line of shops could be erected on the land side of the embankment roadway, the backs of which would form a retaining wall to the ornamental crescent and promenade above them.

"Between Waterloo and Blackfriars bridges, and in front of Arundel-street, a steamboat pier would be constructed, in lieu of the present Essex-street pier, designed upon the same principle as those adjoining the bridges.

"The embankment wall itself has been enriched with mouldings of a simple character, down to the level of high-water mark, the continuous line of moulding being broken by the introduction, at intervals, of massive blocks of granite, to carry ornamental lamps, and by occasional recesses for promenade seats.

"It is proposed in the first instance to construct the embankment wall and fill in behind it to the level of 4 feet above Trinity high-water mark, and afterwards to arrange for the laying out of the area reclaimed. I propose to divide the work into two contracts, the first from Westminster to Waterloo Bridge, which may be let about the end of May or early in June; and the second from Waterloo to Blackfriars Bridge, which may be let before August next."

The number of houses required to be taken for the construction of the Thames Embankment on the north side of the river, situate in Printer's Street, Huish Court, Currier Row, Jackson's, Canterbury, and Green Dragon Courts, in St. Anne's Blackfriars, amounts to thirty-two, consisting of tenements containing from three to eight rooms, and the number of persons to be displaced thereby 437, children included. The number of houses to be taken for the construction of the Southern Embankment in High Street, Vauxhall, Princes Street, Upper and Dower Streets, and Stangate, in Lambeth, is we understand, 124, including seven model lodging-houses, and calculated to displace 1,175 persons, including children.

REVIEWS AND NOTICES OF NEW BOOKS.

London and its Gas Companies; State and Condition of the Companies supplying Gas to the Metropolis, described in a letter to Her Majesty's Principal Secretary of State for the Home Department, with references to the first accounts made out by each Company, in accordance with the Metropolis Gas Act, 1860. By Samuel Hughes, F.G.S., C.E. Waterlow and Sons, 49. Parliament Street, and 66, London Wall, E.C.

This pamphlet contains a complete and comprehensive examination of the present financial condition of the London Gas Companies, showing their absolute proportional capital, their incomes from various sources, and their expenditure under appropriate heads. The working out of these statistical details has evidently been a work of great labour, and is based upon the accounts made out by the Companies themselves, in accordance with a form prescribed by the late lamented Home Secretary, Sir George Cornewall Lewis, under the provisions of the Metropolis Gas Act, 1860. An attentive perusal of this pamphlet will show conclusively the great benefits which the Metropolis Gas Act has placed within the reach of gas consumers. The author points out in the clearest manner, that if the capital of certain extravagant companies be reduced to that of more economical ones, the profits realised by the whole of the companies, would vary from 11 to 16 per cent., according to the companies which are taken for comparison. Under these circumstances, it appears that on every principle of justice and common sense, the gas consumers throughout the metropolis, are entitled to a large reduction of price, inasmuch as the companies are expressly limited under the Gas Works Clauses Act, to a dividend of 10 per cent. The Phœnix and the South Metropolitan Gas Companies, have already been compelled by the operation of the Act, considerably to reduce their prices, and it only requires action on the part of the consumers to compel a corresponding reduction all over the Metropolis.

It is evident, however, that the working of the Metropolis Gas Act and the carrying out of its ample provisions, can no longer be entrusted to the Vestries and District Boards of the Metropolis. These wretched bodies are for the most part so much occupied with their own petty internal squabbles, and in other cases are so much under the influence of Gas Companies and creatures in their interest and employ, that the real interests of the gas consumers are entirely neglected by them. Out of the thirty-nine vestries and district boards constituted under the Metropolis Local Management Act, probably not more than ten have complied with the provisions of the Gas Act, requiring them to provide apparatus and appoint an examiner to test the quality of the gas supplied in their respective districts. Of course this conduct is perfectly illegal, and we presume it is in the power of any ratepayer, by applying to the superior courts, to compel these public bodies to comply with a duty expressly assigned to them by Act of Parliament.

That the magnitude and importance of this question may not be misunderstood, let us direct attention to the long contest which raged during the Metropolis Gas Inquiry, relative to the illuminating power which should be fixed as the standard for the London Gas Companies. The standard which the companies contended for, was that of 12 wax, or rather more than 10 sperm candles, whilst the promoters of the Bill insisted on, and eventually obtained, a standard of 12 sperm candles. The difference between 10 and 12 candles, may therefore be considered the limits within which the gas of the metropolis fluctuates, and a reference to the tables in Mr. Hughes's pamphlet readily enables us to estimate the importance of the question. By reference to table at page 4, we find the aggregate gas and meter rental of all the companies supplying within the metropolitan area, amounts to £1,411,780, and deducting from this £15,653 received for meter rental, there remains for gas alone a yearly rental of nearly one million four hundred thousand pounds.

Now, if the whole of the gas supplied to the metropolis be 10 candle gas instead of 12, it will be found by a simple rule-of-three sum that the metropolis would be paying to the gas companies more than £280,000 a year in excess of the proper amount. It is not intended to report positively that this is actual loss to the metropolis arising from the supply of inferior gas, but it must be observed this would have been, in round numbers, the result of the companies' own proposal as to illuminating power.

The public may be left to judge whether the companies in the absence of examiners and apparatus for testing their gas, are not very likely to relapse into

their own old and favourite standard, in which case, as already shown, the loss to the metroplis would approach £330,000 a year. The same kind of apathy was displayed by the Vestries and District Boards with reference to the sale of Gas Act, which insures to the public the certainty of correct and reliable meters. Fortunate for the gas consumers of the metropolis, that these effete and venal bodies were not entrusted with the carrying out of this Act, which was happily assigned to the Metropolitan Boards of Works, and has ever since been acted on with much vigour and effect.

Mr. Hughes complains that the capital accounts of the London gas companies have hitherto been subject to no such scrutiny, or investigation, as that which took place into the analogous accounts of the water companies in 1851, when the committee, which sat on the subject, referred the investigation of the capital accounts to an accountant who went into the matter in great detail. Had this been done in the case of the gas companies we should not be presented with the anomalies which are now brought to light by Mr. Hughes, who shews that some of the London companies have nearly three times the proportionate amount of capital which suffices for other companies.

Besides the general control given to the Secretary of State, under the metropolis Gas Act, it appears the individual gas consumers have extensive powers under the provisions of the Gas Works Clauses Act, which is incorporated with the Metropolis Gas Act.

By Section 35, of the Gas Works Clauses Act, any two gas rate payers may petition the Quarter Sessions to appoint an accountant, or competent person, to examine and ascertain, at the expense of the gas company, the actual state and condition of the concerns of the company and make a report thereon to the Court. Then follows a provision empowering the Court to reduce the price of gas in case it shall appear, after due investigation, that the profits have exceeded the prescribed rate, which, in the case of the metropolitan gas companies, amounts to 10 per cent. per annum. This power of examination could be most readily exercised by any of the local boards, or vestries, under the Metropolis Management Act, as these are all gas rate payers in respect of the public lamps.

These bodies, however, have hitherto shewn such a complete apathy and such a fixed disinclination to trouble themselves, in any way, for the good of the private gas consumer that any action on their part seems hopeless.

At the same time we urge the attention to this subject of individual consumers, the remedy being trifling and expensive, while it is scarcely possible to conceive, the good which might be effected by speedy and energetic action. Every days experience painfully reminds us of the contrast between the metropolis and the great centres of industry in Lancashire and other parts of Great Britain. Considering the quality of the gas supplied in Lancashire the price is less than one half of that which is charged in the metropolis, while in Birmingham, Bristol, and other large towns the consumers are much dissatisfied with prices far below those of London, and energetic efforts are now being made in introducing new companies in these and other large towns.

Apart from its direct value to the gas consumers, of the metropolis, as shewing them the actual working of all the companies, this pamphlet abounds with valuable tables, which possess the greatest interest and value, in a statistical and engineering point of view, for all those who are desirous of learning the conditions under which new gas companies can be profitably established.

Under this aspect the table at Page 11 is extremely interesting, as it shews, for every one of the London companies, the ratio which the capital bears to the tonnage of coal used in the works. It appears that the aggregate capital of the whole thirteen companies amounts to £5,602,900, and that every £636 of capital represents 100 tons of coal. This is the aggregate working of all the companies, but taking the two extremes there is a wide range of difference. For instance, the Independent Company works with £427 of capital for each 100 tons of coal used in the year; while the London company has £866, or more than double the amount, for each 100 tons of coal. Mr. Hughes shews that five of the principal companies have an average capital of less than £500 for each 100 tons of coal.

We may also direct attention to the tables at pp. 26 and 27, where the whole of the receipts and expenditure of all the thirteen companies are worked out in the most perfect manner and reduced to a standard price per ton of coal.

These tables afford the utmost facilities for calculating all the elements both of old and new gas works as they are founded on the very large basis of a capital represented by nearly six millions sterling, and are, therefore, of much higher value than the experience derived from smaller works.

Viewed in this light the able exposition of these accounts and the accompanying tables will be found of the highest value to all directors, managers and secretaries of existing gas works, and ought to be carefully studied by all who profess to work economically. Their value in the case of contemplated, or new companies, has been already alluded to.

To show the imperfect and erroneous statistics which are frequently circulated, in reference to gas supply, it might be mentioned that in a popular diagram of gas works, issued a few years ago by a publisher in the Strand, it is stated that the consumption of coal for gas making, in the metropolis, equals 350,000 tons per annum. Now Mr. Hughes shows from an examination of the accounts which he has made, that in the year 1861 the consumption of coal for gas making was equal to 882,000, or more than double the above amount, and this, be it observed, is exclusive of a group of nine companies, which are situate on outskirts of the metropolis, and supply partly within and partly without.

In conclusion we strongly recommend this pamphlet to all those who are any way interested either in the establishment of new gas companies or in the working of old ones.

The following works are to hand, too late for notice in our present number, viz.:—

Willson's Science of Ship-building. London: J. D. Porter, 31, Poultry.
Holmes's Magneto-Electric Light, as applicable to Lighthouses.

NOTICES TO CORRESPONDENTS.

S.—Yes; but we have received your note too late to enable us to give the Admiralty order you refer to in our present number. We will insert it in our next.

"Elasticity."—It is intended to embody the particulars to which you refer.

P. O.—Mr. John Seaward was born in 1786, and died March, 26th, 1858. Amongst the engines built by Messrs. Seaward and Co. for steamships in H.M. Navy may be mentioned the *Volcano, Megæra, Alecto, Prometheus, Ardent, Polyphemus, Driver, Styx, Vixen, Geyser, Growler, Montezuma, Firebrand, Penelope, Avenger, Sidon, Leopard, Blenheim, Hogue, Conflict, Horatio, Nile, Termagant, Caradoc*, and many others of less importance. At the same time they adapted their engines to many large vessels for the Hon. East India Company, for the Steam Navigation Companies at home, as well as for various Governments and companies abroad.

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisiens to our readers in a plain, familiar, and intelligible shape.

Application for Prolongation of Patent, *Bovill.*—The Judicial Committee of the Privy Council recently set in this case. A petition for a prolongation of Bovill's patent for grinding corn (part heard) was concluded. The Master of the Rolls gave judgment on the part of their lordships, granting an extension for five years. The lords present were the Master of the Rolls, the Lord Chief Justice Erle, and Sir E. Ryan.

Martin *v.* Gray.—Mining Case.—Mr. Thomas Martin, a merchant, of Wadebridge, sued Mr. Thomas Gray, colonial broker, of London, as a partner in the Messer Mine, for goods supplied to the mine. Mr. Collier, Q.C., in stating the case, said that the plaintiff supplied goods, from the order of Captain Rich, the manager of the mine, to the extent of more than £200, chiefly coals and things absolutely necessary to work the mine; all of them were used in the mine, and helped to realise such gains as were obtained. A fair quantity of ore was raised, and the mine paid its way for some time, but not altogether. The plaintiff, acting as a prudent man, never would have supplied the goods but for Mr. Gray's visit to the mine, and the interest he took in it. This was not a limited liability concern, or a joint-stock company, but a private partnership, in which each partner was liable for the debts of the company, and could recover a contribution from the other partners. Mr. Gray was sued because he was the only substantial man in the concern, those associated with him being merely men of straw. Captain Rich, the captain of the mine, was the principal witness against the adventurer. The defence was that Mr. Gray had advanced money to Gregg, a shareholder in the mine, and had gone to see it, as he had an option to become a shareholder, but did not do so. Mr. Gray stated that the whole of his advances amounted to upwards of £1000, not one farthing of which has yet been returned. Mr. Gregg stated that he had received the money from Gray as loans, and contradicted some of the statements of Captain Rich. Mr. M. Smith, Q.C., having summed up the evidence for the defence, Mr. Collier, for the plaintiff, replied upon the case. He said that this was a case of great importance, as it was an endeavour to put forth an optional partnership—if the mine was successful Mr. Gray was to be partner, but if it was not then Mr. Gray had nothing to do with it. If such an optional partnership was to be tolerated, there would be a complete change in commercial affairs. The learned Judge (Mr. Justice Byles) then summed up the whole case to the jury. He said the sum claimed amounted to £236 13*s.* 4*d.*, without interest. This was a case of very great importance to the parties, and, he might almost say, to the public. It was a case of considerable importance to the plaintiff, because he had unquestionably supplied these goods, and it did not seem, so far as could be collected, that he was likely to be paid in any other way. It was of great importance to the defendant, because he had derived no profit, but a very great loss, from his connection with the mine to which those goods were supplied, and very intelligible hints had been thrown out in the course of this enquiry that this was but the precursor of many other like demands upon him. He was sure this case had received their most attentive consideration. They had had the advantage, and he had had the advantage, of hearing this matter discussed by very able counsel, who were just as able as any men in England to dissect evidence, and to show how the various parts of it bore one upon the other. Partly for that reason, and partly owing to the great pressure of business, his address to them would be very short. He would not trouble them with many observations on the conflict of evidence, but would content himself with telling them the questions for their determination, and make one or two observations on the leading and salient points of the case. After carefully going through the evidence, his Lordship told the jury that if they thought the defendant Gray had stipulated, when he made either of the three advances, that he should have a share in the profits of the mine he was liable; and if he did not so stipulate, yet held himself out to the world and the plaintiff as a partner, and if plaintiff trusted him, he was liable. If, on the other hand, they were of opinion that he had no interest in the mine except the option of taking shares in it, and that he never had these shares or anything at all to do with them, but was a mere creditor, and nothing more, they would find for defendant, as they also would if they thought the goods were not supplied on the credit of the defendant, and not of the machinery. The jury gave a verdict for the plaintiff for £236 13*s.* 4*d.*, without interest.

The Mid-Level Compensation Case.—A Norwich special jury, under the presidency of Lord Chief Justice Earle, have recently been for five days engaged in investigating an action Coe *v.* Wise, Clerk to the Mid-Level Commissioners—for negligence in not making and maintaining the outlet sluice of the Mid-Level, by reason of which the tidal waters broke through and ran over the sluice, submerging the plaintiff's land. The importance of this trial may be estimated from the fact that no fewer than 107 compensation claims, involving about £70,000 damage, have been awaiting its decision. At the close of the trial the Lord Chief Justice put it to the jury First, was damage caused to the plaintiff by the absence of due skill and care on the part of the defendant in making the sluice; secondly, in maintaining the sluice; thirdly, in providing remedies against mischief after the sluice was destroyed; and, fourthly, by reason that no puddle clay wall was made along each side of the banks of the cut? The verdict was returned for the defendant on the first issue, and for the plaintiff on the three last issues—virtually a verdict for the plaintiff. The question of damages will be settled out of court.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention—Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

The Largest Carriage Manufactory in the World is that of a Berlin company, formed for the supply of railways. Last year it is said to have employed 1552 men, and to have made sales to the amount of about £270,000. It delivered during the last year 290 railway passenger carriages, 993 goods waggons, 187 post, military, and other various carriages. It began the new year with orders rendering it pretty certain that this year will exceed the last in prosperity. Considerable deductions have been made for reserve fund, &c., a dividend of 8½ per cent. has been declared.

The Paris Permanent Exhibition.—*Le Siècle* gives the following account of the progress of the palace which is being built in Paris for an universal and permanent Exhibition, and of which all the cast iron works have been sent from Glasgow:—"The winter has been so mild that the building of the Auteuil Palace has been uninterrupted, and is now far advanced. The stone work is fully 30ft. high, and a good many columns and girders have already been set up. All the heavy iron works are on the spot, and that is the most important thing of all. It is a most curious sight to see the workshop where the iron pieces are turned and finished, and thence removed on railway trucks, and raised by travelling cranes to the places they are to occupy. That shop alone employs 370 men and 23 engines. The dome will be the principal feature of the building, and next in importance will be the front entrance, which forms an arcade 70ft. high and 50ft. wide, surmounted by a group of figures of 15ft. The building will have another door of equal size, with fewer ornaments, besides eight smaller ones. In a formal notice we stated that other buildings would be annexed to the Palace, each for a specific purpose. In a few days they will begin to lay the foundations of one of these supplementary buildings, which is intended for the exhibition of machinery, and will measure 400ft. in length and 120ft. in width.

Tools at Woolwich.—A contract has been entered into between the Admiralty and Messrs. Smith, Beacock, and Tannett, the machine tool-makers of Leeds, for the supply of their special machinery to Woolwich Dockyard, for the purpose of planing, shaping, drilling, and slotting the armour-plates still to be attached to the iron-cased ship *Caledonia*, and also those of the corvette *Favourite*, ordered to be completed forthwith. The machinery, although on a much larger scale, will be similar in most respects to that employed with success in Keyham Dockyard and the manufacturing departments at Woolwich Arsenal.

NAVAL ENGINEERING.

Trial of the "Royal Oak."—The official trial of the *Royal Oak* took place on the 26th March last. On getting under way the *Royal Oak's* draught of water was found to be 23ft. 1in. aft, and 20ft. 4in. forward, which was somewhat less than on the previous day. Six runs were made at the measured mile at full speed, the following being the results:—In the first run the time was 5min. 30sec., the speed in knots was 10·909, the number of revolutions of engines 60, and the pressure of steam 21; in the second run the time was 4 min. 13 sec., the speed in knots 14·229, the number of revolutions of engines, 59, and the pressure of steam, 19½; in the third run the time was 5 min., 30 sec., the speed in knots, 10·909; the number of revolutions of engines, 60, and the pressure of steam, 20; in the fourth run the time was 4 min., 18 sec., the speed in knots, 13·953, the number of revolutions of engines, 59½, and the pressure of steam, 20; in the fifth run the time was 5 min., 30 sec., the speed in knots, 10·909, the number of revolutions of engines, 59, and the pressure of steam, 19; in the sixth run the time was 4 min., 17 sec., the speed in knots, 14·008, the number of revolutions of engines, 61, and the pressure of steam, 20. In all the runs the vacuum forward and aft was 24. The mean speed of the six runs was 12·487 knots. The engines of the *Royal Oak* are of 800-horse power (nominally), while those of the *Black Prince* are 1250-horse power, and yet on the occasion of the last trial trip of the latter vessel she only attained a mean speed of 12·209 knots, the *Royal Oak* thus beating her by a quarter of a knot an hour. The actual displacement of the *Royal Oak* during her trial was 6500 tons, and this mass was driven through the water at a speed greater than that attained by the largest of the iron frigates, with the exception of the *Warrior*. At the termination of the runs at full speed, it was determined to try the vessel at half-boiler power, and four runs were accordingly made at the measured mile, with the following results:—In the first run the time was 6 min. 45 sec; the speed in knots, 8·89; the number of revolutions of screw, 47; and the pressure of steam, 19; pitch of screw, 27ft. 6in. In the second run the time was 5 min. 9 sec.; the speed in knots, 11·650; the number of revolutions of screw, 49; and the pressure of steam, 20; pitch of screw, 27ft. 6in. In the third run the time was 6 min. 29 sec.; the speed in knots, 9·254; the number of revolutions of screw, 47; and the pressure of steam, 20; pitch of screw, 27ft. 6in. In the fourth run the time was 5 min. 46 sec.; the speed in knots, 10·405; the number of revolutions of screw, 47; and the pressure of steam, 20; pitch of screw, 27ft. 6in. In all the runs the vacuum fore and aft was 24. The average speed of the four runs at half-power was 10·140 knots. At the termination of the trials of speed some experiments were made in order to test the time in which the half-circle would be made. Four runs were accordingly made, with the following results:—First run, helm put hard a-starboard, with four men at the wheel, and the rudder at an angle of 18 deg., half circle made in 2 min. 29 sec.; second run, helm at port, and rudder at 17 deg., half circle made in 2 min. 34 sec.; third run, helm at starboard, half circle made in 2 min. 42 sec.; fourth run, helm at port, circle made in 2 min. 39 sec. At half-boiler power the helm was put hard a-starboard by four men with three turns of the wheel, and the rudder at an angle of 15½ deg., when the half-circle was made in 3 min. 40 sec., the screw making 39 revolutions per minute, and the diameter of the circle 300 yards. The helm was then put hard aport, at an angle of 14½ deg., and the half circle made in 3 min. 32 sec. Commander Crewe-Read, who superintended the trials, then directed the helm to be put hard a-starboard to an angle of 18 deg., and the ship going at full speed, with the screw, making 54 revolutions, the complete circle was made in 6 min. 38 sec., the diameter of the circle being a little more than double the vessel's length.

Trial Trip of the "Anglia."—The present fleet of the Atlantic Royal Mail Company is now completely ready for sea, and in a condition to commence immediate operations, the fourth of their large paddle-wheel steamers, the *Anglia*, on the 10th ult., having made a most successful official trial at the measured mile in Stokes Bay. Like her sister ship, the *Columbia*, this vessel has been materially strengthened and improved since her first build, Messrs. Laird and Sons, of Birkenhead, having executed the work connected with the hull, while the machinery department was placed in the hands of Messrs. Ravenhill and Salkeld, of London. The *Anglia* ran the measured mile four times with the following results:—1st run, 4m. 16s., equal to 14·063 knots per hour; 2nd run, 4m. 26s., 13·533 knots; 3rd run, 4m. 22s., 13·740 knots; 4th run, 4m. 16s., 14·063 knots; revolutions of engines throughout, 21. This gave a true mean of 13·742 knots per hour, being about a quarter of a knot faster than the speed attained by the *Columbia*, although the two vessels are alike in every respect. During the trial the pressure of steam was 26lb., and vacuum 26 inches, force of wind 3. She had about 900 tons weight of coal, water, &c., on board. The draught of water was 19ft. 8in. forward, and 19ft. 4in. aft. After leaving the measured mile the *Anglia* was turned round while at full speed, completing the circle in 7 minutes 35 seconds. Every portion of the machinery worked admirably, and very little vibration was felt in any part of ship when she was running at the highest rate of speed. The Government surveyors present expressed their perfect satisfaction with the *Anglia's* performances during the trial.

Trial of the "Sparrow."—The screw steam gun vessel *Sparrow*, 5, was taken outside the breakwater, Plymouth, on the 11th ult., to test her engines and machinery, preparatory to her departure for her station on the West Coast of Africa. She is of 430 tons burden, is built of wood, and, being fully equipped for sea, draws 11ft. 3in. aft, and 10ft. 6in. forward. The maximum speed attained with full boiler-power was 10·2 knots; the average, 9·817 knots; with half boiler-power, 7·041 knots. This result is considered highly satisfactory, and will bear comparison with that of any other ship of the same class. The number of revolutions per minute was 105. The helm in still water can be put over to 31 deg.; but when the rudder is in vigorous action the force of the sea upon the steering tackle reduces it to 27 deg. A circle was performed under full speed in 4m. 13s.; with half boiler-power, 2m. 20½s. The engines possess 60 horse power, and are from the manufactory of Messrs. Napier.

Trial Trip of the "Leander."—The *Leander*, 51, 2760 tons, 400-horse power, was taken from her moorings in Sheerness harbour on the 15th ult., for the trial of her machinery at the measured mile off Maplin Sands. The trial was not quite successful, owing to excessive priming, and the vessel was therefore taken out again on the following day, when a completely successful trial was made, with the following results:—True mean speed at full boiler-power, 10·448 knots per hour; revolutions—maximum 57, mean 55 to 56 per minute; pressure of steam, 20; vacuum, forward and aft, 24; draught of water, fore 19ft. 9in., aft 21ft. 11in.; temperature—main deck, 56 deg.; engine-room, 68 deg.; stokehole, maximum 110 deg., minimum 74 deg. The vessel is fitted with Griffith's screw, pitch 24ft., length 3ft., immersion of upper edge 2ft. 5in.

The "Pandora," 4, screw, has completed her trials of speed at Portsmouth with full and half boiler-power, realizing a mean speed in knots with the former of 8·528, and with the latter of 5·430. At the full boiler-power trial the temperature ranged:—On deck, from 51 to 58 deg.; in the engine-room, from 65 to 70 deg.; and in the stokehole, from 80 to 95 deg.

Trial Trip of the "Conqueror."—The screw steam line-of-battle ship *Conqueror* (late *Waterloo*), 86, 2845 tons, 500-horse power, was, on the 17th ult., taken from her moorings in Sheerness harbour to the measured mile off Maplin Sands for trial of her machinery, after being brought forward and placed in the first division of the steam reserve some months ago. The results of the trial are as follow:—True mean speed at full boiler-power, 9·935 knots; half boiler-power, 8·126 knots per hour; revolutions, maximum 63, mean 61·3 per minute; vacuum, fore 24½, aft 23; draught of water, fore 23ft., aft 24ft. 9in.; temperature, on deck 58 deg., engine-room 74, stokehole, maximum 104, minimum 94. The circle was made at full boiler-power, with helm port 17 deg., in 6m. 30s.; revolutions, 54 per minute; the diameter of circle being 500 yards at half boiler-power, with helm starboard 20 deg., in 6m. 27s.; revolutions 50 per min., diameter 400 yards. The half circle was turned at full speed in 4m. 29s., and at half speed in 3m. 40s. She is fitted with Griffith's propeller, pitch 20ft., but variable from 17ft. to 22ft.; length 3ft. 9in., diameter 18ft. The trial was made in a smooth sea, with the force of the wind very slight. It was perfectly satisfactory.

The Trial of the Iron Screw Steam Transport "Orontes," 3, recently built for the Admiralty by Messrs. Laird, Birkenhead, took place outside Plymouth breakwater on the 16th ult. The trial was under the supervision of Captain Astley C. Key, C.B., and Mr. A. Dinnen, inspector of machinery from the guardship of steam reserve, Indus, in Hamoaze. The weather was very fine. The *Orontes*, which is built entirely of iron, and has her lower mast stepped, has a burden of 2812 tons, and draws 17ft. 11in. aft and 17ft. 3in. forward. The engines, direct acting, are of 500-horse power nominal, but were worked up to 2020-horse power; cylinders horizontal; diameter, 31in.; stroke, 36in. The screw shaft is about 110ft. long by 13in. diameter. The screw is Griffith's shifting; diameter, 18ft.; pitch, 25ft. The mean speed obtained from six runs was 13·292 knots, which, when it is recollected that the ship had been in the water since the beginning of December, and that her bottom could not consequently be clean, is considered very fair. The maximum number of revolutions was 63 per minute; the mean number of revolutions at full power 61½; the pressure 25lb. to the square inch. There were no indications of hot bearings or of priming. The engines of the *Orontes* are similar to those of the *Prince Regent*, *Sanspareil*, and *Barossa*, by the same manufacturers. This transport has accommodation for 1150 troops. The trial under steam appears to confirm the anticipations of her good qualities for speed expressed when she was launched on the 22nd of November last at Birkenhead.

The "Black Prince," 40, iron frigate, coaling in No. 10 dock, at Portsmouth, will be undocked about the 4th inst. Her bottom has been scraped over, and it is now ordered to be coated with the McInnes composition on one side, and with the composition prepared by Mr. Hay, the Admiralty chymist, on the other, in order to obtain a comparative result of their respective merits. A good deal of corrosion is visible in places, but the most serious injury exists on the third streak of plating below the armour-plates. These results forcibly illustrate the danger which must always attend the use of copper compositions, as at present applied to the bottoms of iron ships. For about 40ft. along this streak of plating, where the vessel is broadest, there run straight lines of indentations irregular in number, averaging about an eighth of an inch in width, and at their greatest depth about the sixteenth of an inch. The ship has here evidently rubbed against some-

thing, possibly the staging alongside the dockyard on first leaving the dock, and scraped through the composition to the surface of the iron, and this done a powerful battery has been at once formed, the power of which to destroy the ship was only a question of time. In the instance of the *Black Prince* this power has been arrested, but it is a proof that all iron ships coated with copper preparations require frequent docking to ascertain whether the outer surface of the composition is undisturbed.

TRIAL OF THE "HEBE."—The trial trip of this twin screw steamer took place on the 25th ult., between the Nore and Mouse lightships. The *Hebe* is the third vessel on this principle which has been built and engined by Messrs. Dudgeon of the Isle of Dogs. The performances of the first two—the *Flora* and the *Kate*—have already been noticed in our columns. The *Hebe* is an iron vessel, of 470 tons, 165ft. long, 23ft. beam, 13ft. 6in. deep, having a deck house 7ft. high extending about three-fourths of her length, fitted up with cabin and saloons. Draught of water at time of trial, 5ft. forward and 9ft. aft. Being without dead weight to give her sufficient immersion, the vessel was under considerable disadvantages, especially as there was a strong wind blowing, which materially retarded those revolutions which formed the principal feature of interest to most present. The screws were three-bladed, 7ft. 6in. in diameter, with 15ft. pitch, worked by two separate and independent engines, having each two cylinders 21in. in diameter, with 26in. stroke of pistons, and 120 collective nominal horse power. The revolutions at the time of trial between the lightships were 110. The time occupied between the Mouse and Nore lightships was 33 min. 15 sec., the distance being eight statute miles. Among the evolutions performed for the satisfaction of the scientific gentlemen present, were the following:—1. Full speed ahead with both screws helm hard a starboard; circle completed in 4 min. 2. Full speed ahead, both screws, helm hard aport; 3 min. 40 sec. 3. Helm a starboard, with port screw stopped; circle completed in 3 min. 9 sec. 4. Circle made the reverse way by putting the helm aport and with starboard screw stopped, in 3 min. 38 sec. 5. Helm hard aport, the screws being turned in opposite directions, the vessel pivotted on her centre in 3 min. 52 sec. 6. A second experiment the reverse way was made in 4 min. 10 sec., the mean time of these last two revolutions being 4 min. 8 sec. 7. Helm amidship, the screws working in opposite directions; the circle was completed in 4 min. 58 sec. The engines varied alternately in these trials from 90 to 103 revolutions per minute. As before mentioned, during these experiments a fresh wind prevailed, which materially retarded the turning, the vessel being light, and consequently exposing a large area to the wind. The engines worked admirably throughout, the boilers giving an abundance of steam, and the whole of the arrangements were excellent, reflecting great credit on the builders. We may add that during the trial luncheon was served on hoard in very excellent style by Mr. G. J. Atkins, of the World's End Tavern, Tilbury. Mr. Atkins is becoming deservedly well known as a caterer upon such occasions.

THE TRIAL OF THE "JASEUR," 5, screw steam gun vessel, 425 tons, 80 horse power, commissioned for service on the West Coast of Africa, took place at the measured mile off Maplin Sands on the 21st ult. The trial was most satisfactory. The following were the results:—True mean speed at full boiler power, 8·398 knots per hour; revolutions, maximum, 102, mean 99 per minute; pressure of steam, 20lb., and vacuum gauge, 25½. At half boiler power the true speed attained was 6876 knots; revolutions, maximum, 87; mean, 81½. The circle was made at full boiler boiler, helm starboard 35 deg., in 4 min. 7 sec.; revolutions, 92: diameter of circle, 200 yards; at half boiler power, helm starboard 35 deg. in 5 min. 17 sec.; revolutions, 73; diameter, 300 yards. The half circle was made at full boiler power, helm port 28 deg., in 2 min. 16 sec.; helm starboard 31 deg., in 1 min. 48 sec.: at half boiler power, with helm port 31 deg., in 3 min. 30 sec., and with helm starboard 32 deg., in 2 min. 57 sec. The vessel was started full speed ahead in 4 sec., and stopped in 6 sec. She was started full speed astern in 7 sec., and stopped in 6 sec. The force of wind was from 5 to six; and the draught of water, forward, 10ft. 8in.; aft, 12ft. The pitch of the screw was 12ft.; diameter, 9ft.; immersion, 1ft. 6in.; temperature, on deck, 53 deg.; engine-room, 84 deg.; stoke-hole, 90 deg.; weather barometer, 29·80 deg.

COST OF SHIPS.—An account has been issued showing the charges for works upon Her Majesty's ships in the financial year 1861-2. The sum of £613,829 was expended in building vessels in the dockyards, and £932,323 in building by contract or purchasing; also £368,202 upon ships commenced as wooden ships but converted into iron-cased vessels while building, and £118,480 upon ships launched as sailing ships, and subsequently converted into screw steamships. The sum of £1,003,048 was expended in fitting out or refitting steam vessels and in repairs and maintenance; also £183,395 in fitting out, refitting, repairing, and maintaining steam vessels permanently employed as troop, store, or surveying vessels, tenders, yachts, &c., and £63,898 for sailing vessels, £69,168 was laid out in the building and maintainance of yard craft, steam tugs, &c., and £9,612 in fitting and maintaining hulks. Details are given for each ship. The Accountant-General proposes to submit a further account for the same year, showing the cost of manufacturing and repairing articles of store in the several workshops and factories in the dockyards; and to supply before the close of the Session an account showing the value of the stock in hand in each dockyard on the 31st March, 1863.

THE AUSTRIAN IRON FLEET.—The Austrian iron-clad frigate, *Don Juan of Austria*, completely iron clad and equipped, left the Port of Trieste on the 16th ult. She goes afterwards to Pola to take on board her guns. There will thus be at Pola, in a very short time, the entire squadron of five iron-clad men of war, all ready for sea and active service.

NAVAL APPOINTMENTS,—The following appointments have taken place since our last. E. J. B. Bird, Chief Engineer, to the *Cumberland*, for the *Cadmus*; J. Grant, Acting Assist. Engineer, to the *Asia*, as supernumerary; R. S. Willcocks, Assist. Engineer, to the *Pandora*; J. L. Davies, of the *Sphynx*, promoted to Engineer; H. Williams, Chief Engineer, G. Lynch, Engineer, H. White, and J. Dingwall, Assist. Engineers, to the *Archer*; T. Baldwin, First-class Engineer, to the *Fisgard*, as supernumerary; W. P. Guyer, in the *Narcissus*, promoted to Acting Engineer; T. Waterlow, Chief Engineer, to the *St. George*; W J. Ibbet. and C. F. Serjeant, Chief Engineers, to the *Pembroke* and *Urgent*, respectively; J. Roberts, Acting Chief Engineer, to the *Indus*, for the *Orontes*; T. Parker, Engineer, J. D. Lamont, and F. E. Shean, Assist. Engineers, to the *Jaseur*; J. Watt, of the *Hastings*, for the *Griper*; J. C. Williams, of the *Black Prince*, R. W. Jones, of the *Asia*, lent to the *Warrior*; L. Thompson, of the *Spider*, G. Thompson, of the *Fisgard*, T. Ball, of the *Leven*, and F. Wheeler, of the *Rattlesnake*, promoted to Engineers; S. Lawton, of the *Sparrow*, J. Pearse, of the *Malacca*, D. P. Steddy, of the *Immortalité*, N. Farrant, of the *Wrangler*, and G. H. Loxdale, of the *Topaze*, promoted to be Acting Engineers; R. Williamson, Chief Engineer, and J. Ross, Engineer, to the *Valorous*; J. Dyson, in the *Harrier*, promoted to Acting First-class Assist. Engineer; W. Russell and F. S. Turner, Assist. Engineers, to the *Valorous*; G. T. Stronach, Assist. Engineer, to the *Cumberland*, as supernumerary; T. Bullions, Chief Engineer, and J. Etherington, and W. Skelton, Assist. Engineers, to the *Hannibal*; W. Wotton, Chief Engineer, R. W. Hulford, Engineer, W. B. Cottam, J. Wendover, and G. Fordham, Assist. Engineers, to the *Leander*; C. F. Hulford, Assist. Engineer, to the *Cumberland*, for the *Arethusa*; J. Forster, Assist. Engineer, to the *Indus*, for the *Aurora*; R. W. Watson, in the *Petrel*, promoted to Acting Engineer; J. D. Lamont, Assist. Engineer to the *Cumberland*, as Supernumerary; W. Ball, Assist. Engineer, to the *Jaseur*; W. Fenton (a) and G. Edwards, Assist. Engineers, from the *Revenge* to the *Edgar*, for the *Trinculo*; R. J. Wemyss, Chief Engineer to the *Curaçoa*; F. Brockton, Engineer, to the *Fox*; R. T. Martell, Engineer, to the *Vigilant*; J. Rice, J. Slater, and G. Patterson, Assist. Engineers; and J. Merser, Acting Second-class Assist. Engineer, to the *Curaçoa*.

MILITARY ENGINEERING

EXPERIMENTS AT SHOEBURYNESS.—On the 27th March the members of the Ordnance Select Committee and the Ironplate Committee, made some novel gunnery experiments at Shoeburyness, both with cannon and forms of projectiles. The first was made by the Ordnance Committee entirely, and consisted of trials to ascertain how far a method now rather in favour among French artillerists, by which a series of holes, about an inch in diameter, are bored through the substance of the cannon near its muzzle, in order, by permitting a quick escape of gas, to diminish its recoil, affects the service of the piece as to range and accuracy. The experiments were made with two brass nine-pounder ordinary smooth-bore field pieces, which were loaded with the usual service charges and spherical shot. Five rounds were fired from each gun in succession, the recoil of both being carefully measured after each discharge. They were then shifted, so that each occupied the platform which had been used by the other, when again more rounds were fired. The general merits of the performances of each gun could be seen at a glance, and were exactly what were anticipated before a shot was fired. The recoil of the ordinary gun was, in round numbers, just twice as great as that which had the holes bored round the muzzle, while the range and accuracy of the latter were scarcely more than half as good as that of the common piece. The lateral escape of gas and flame through the side holes of the French gun was very great indeed, so much so as to prove at once that even if the gun otherwise possessed the most transcendent merits it could never be used either on shipboard, in casemates, or even at embrasures. In the open air the trigger had to be pulled by a lanyard nearly 20 yards long. One half of the force of the explosion evidently escaped through the side holes before the force of the powder was expended on the shot, and virtually therefore the barrel of the gun is shortened by as much of its length as is thus perforated. The results obtained with this curiously bored gun on Friday were enough apparently to satisfy the Ordnance Committee that it would be a waste of time to continue the experiments further. Some experiments were then made with the Armstrong 110-pounder service-gun, loaded with steel shot, against a box target faced with 4½-inch plates, and lined inside with teak and an iron skin like the *Warrior*. The only interest of this experiment was to test the penetrative power of the projectiles, one of which was prepared by the Ordnance Committee, weighing 65lb. and fired with a 16lb. charge of powder. The immense superiority of this projectile over the cast iron and wrought iron shot, which, as the standards or units of penetration, were fired at the target before, was at once apparent. Its indentation was nearly 50 per cent. deeper than either the wrought or cast iron missiles. The next shots tried were those of a peculiar kind of steel made by Messrs. Makin and Sons, of Sheffield. This occasion was the third time that steel shots supplied by this firm have been tried at Shoeburyness, and always with the same result—that their metal, both for toughness and hardness, is superior to any other kind that has yet been experimented upon. A conical-headed shot of this kind, of which the cone was small and sharp, with a very full shoulder, weighing 65lb. and propelled by only 14lb. of powder, smashed its cone completely through the plate, damaging the backing and breaking a rib behind—the greatest result that has ever been obtained with so light a shot and so small a charge. It was evident that only the very full form of the shoulder beneath the cone (part of which was sheared off) prevented the whole going completely through the target. A second shot of the same kind, the same weight, and fired with the same charge, struck the upper plate of the target on an uninjured part, and about 12in. from its edge. It completely smashed away a piece about 15in. deep, by 18 or 20 wide, splintering and ripping up the backing behind. One piece of the plate, of considerable weight, was carried far behind the target where it fell with the shot itself. An examination of the latter showed a part of the cone broken off, but in other respects it was little injured, though the injury to the target was very formidable, in spite of the hard, rather than tough, character of its metal. The trial seemed to show that to pierce the plates almost as much depends upon the metal of the projectile as upon either the gun or charge of powder which fires it. Certainly, the result seemed quite to upset the notion that a flat-headed shot is essentially necessary to punch armour plates, and, on the other hand, to strengthen the belief that the best form for this purpose may, after all, and with proper metal, be found to be the conical form adopted by Sir William Armstrong.

AUSTRIAN GUN COTTON.—Take cotton yarn and twist it into strands of suitable size to answer the same purpose as grains in gunpowder. (The size of these strands can only be ascertained by experiments.) It is then steeped for a few minutes in nitric acid contained in a stoneware vessel, squeezed, and thoroughly washed by water, which is permitted to fall upon it from a pipe set at a height of several feet. After this it is squeezed, and dried in a room heated to 130 Fahr., when it is ready to be treated with a mixture of nitric acid of 1·52 specific gravity, and sulphuric of 1·14 specific gravity. These acids, in equal quantities, are mixed together in a glass or stoneware vessel, and allowed to stand for twenty-four hours, then the prepared yarn is immersed in it for forty-eight hours, with occasional stirring; the vessels being covered; then it is squeezed, washed for several hours in running water, and dried again. After this it is soaked for a short period in dilute silicate of potash, squeezed, washed again, dried, and is fit for use. This gun cotton is manufactured by M. Reny, of Vienna. It emits but little smoke, and is not subject, like common gun cotton, to explode by percussion.

STEEL FOR FIREARMS.—Captain Caron has been for some time addressing papers to the Academy of Sciences about his experiments on steel, effected at the Depôt des Poudres et Saltpêtres, for the pupose of applying that metal to ordnance and firearms in general. More than twelve months ago, samples of a peculiar soft steel were brought to the artillery factories, and the remarkable qualities of this metal induced Colonel Trielle de Beaulieu, the director, to apply it to the manufacture of tubes intended to protect the copper of the points of sight of heavy ordnance. This steel has the property of drawing cold, in tubes of any dimensions, and after drawing—above all, if the metal be tempered—the grain, perfectly homogeneous, is fine and watered, the steel has become strengthened (*nerveux*), and offers an extraordinary amount of resistance. Since then, gun barrels, manufactured from the same material, have been presented to the factory for the models of arms, and Captain Maldin, director of this establishment, struck by the beauty of this metal, thought it his duty to try the barrels, in order to establish their quality. The following are the very curious results at which this officer has arrived:—A gun barrel of the ordinary dimensions of that of a sporting gun, after having been trued, was tried first with 30 grammes (1 oz.) of powder, and one ball of 37 grammes (1¼ oz.) This charge, producing no deterioration, was followed by trials with a ball of the same size, and increasing the charge by 10 grammes at a time up to 60 grammes (2oz.) The 60 grammes were then replaced by 40 grammes of extra fine Esquerdes powder (the most destructive powder known). Not being able to burst the barrel, the experiments were continued with gunpowder, and after some trials, a charge of 150 grammes (5oz.) was arrived at without inducing a rupture. A last experiment was then tried, in which 150 grammes (5oz.) of powder and five balls were employed, the latter weighing together 135 grammes (say 4½oz.) well rammed home The only injury seen was a swolling in the barrel at the spot where each of the balls were placed, but the barrel was not burst, not even cracked. If it be considered that the charge of powder was already 23in. long, and that a more considerable quantity would not have had time to burn entirely, it may be fearlessly concluded from these experiments that the metal employed in the manufacture of these barrels is capable of giving arms which cannot be burst by the effort of any charge of powder whatever.

THE ARMSTRONGS.—Admiralty instructions have been received at Chatham, directing that particular care is to be used in increasing the strength of all breeching bolts, in order to resist the enormous strain of the recoil of the Armstrong guns owing to their lightness as compared with the shot fired.

STEAM SHIPPING.

The Peninsular and Oriental Company's Fleet.—Two of the eight new vessels by which the Peninsular and Oriental Company's already numerous and powerful steam fleet is about to be augmented—viz., the *Poonah* and the *Carnatic*—are now completed and ready for sea. The first of these had her official trial trip on the 11th ult. The *Rangoon*, built by Messrs. Samuda, has recently been launched; the *Syria*, building by Messrs. Day and Co., of the Northam Ironworks, at Southampton, will be ready about September next; the *Golconda*, by the Thames Ironworks Company, at the end of the year; the *Delhi*, by Messrs. Wigram, in the spring of 1864; the *Baroda*, by Messrs. Samuda, in the summer of 1864; and orders have just been given to the Thames Iron Company to construct a new paddle steamer which is not yet named. All these vessels are screws, with the exception of the *Syria* and the one last mentioned. The *Poonah* is a magnificent screw steamer, built and equipped by the Thames Ironworks Company at Blackwall, and fitted with engines of 500-horse power nominal by Messrs. Humphrys and Tennant, of Deptford. The length of the *Poonah* is 315ft.; extreme breadth, 41ft.; depth of hold, 30ft.; tonnage, builders' measurement, 2596; 3370 tons displacement. She has 609ft. of section and 226ft. of firebar; and her indicated horse-power is 2356. She has a pair of compound engines, on the same principle as those of the *Mooltan*, but laid horizontally instead of vertically, as in that vessel, and at a moment's glance will convince the most unpractised eye that engines of this character are well adapted for ships of war, they being out of the way of all shot. The vessel is steered by Mr. Humphrys's hydraulic steering gear, which has been found to answer so well in the *Mooltan*, and among other numerous ingenious inventions she is fitted with Captain Field's improved compass corrector and course register. The following is the result of four runs at the measured mile in Stokes Bay.—First run, 4 minutes 4 seconds, equal to 14·754 knots per hour, 64 revolutions; second run, 4 minutes 52 seconds, equal to 12·329 knots, 64 revolutions; third run, 4 minutes 11 seconds, equal to 14·342 knots, 61 revolutions: fourth run, 4 minutes 51 seconds, equal to 12·371 knots, 63 revolutions; the true mean of the whole being 13·391 knots per hour. Pressure of steam, 25lh.; vacuum, 25; weight of coals, water, &c., on board, 893 tons. She ran on an even keel, the draught of water being 19ft. 11in., both fore and aft. When at full speed the ship made a full turn in 8 minutes. The machinery worked in the freest manner throughout the trial.

The Trial Trip of the "Princess Alexandra" took place on the 8th ultimo. The *Princess Alexandra* has lines well adapted for sea-going qualities. Her length between perpendiculars is 176ft.; breadth, extreme, 24ft.; depth, 14ft. 7in. She has a pair of engines by Messrs. Penn and Son, each of 90 horse-power, but capable of working up to six times that power. The engines are upon the oscillating system, the cylinders of 52in., stroke 4ft. At the measured mile off the Lower Hope, the distance was run against tide in 4 min. 45 sec., giving a speed equal to 12·63 knots per hour. On returning with the tide, but against a strong head wind from S.W., the measured mile was run in 3 min. 46 sec., equal to a speed of 15·9 knots per hour. The mean of the run was at the rate of 14·26, being nearly $1\frac{1}{2}$ knots above the contract speed.

Trial of the New Steamer "Carnatic."—This handsome vessel was built on the Thames, by Messrs. Samuda, and engined by Messrs. Humphrys and Tennant, of Deptford. Her keel was laid on the 30th of January, 1862, and she was launched on the 6th December last. The following are her dimensions:—Length over all, 315ft.; length between perpendiculars, 285ft.; extreme breadth, 38ft.; depth of hold, 28ft.; tonnage, builders' measurement, 2014; displacement, 2800 tons; midship section immersed, 548ft. She is fitted with a pair of combined cylinder engines, inverted, with surface condensers, two of the four cylinders being 43in. diameter and the other two 96in., with 3ft. stroke, and Lamb's patent sheet flue boilers. She is propelled by a two-bladed screw, with the leading corners cut off, diameter 16ft., and 23ft. pitch; and steered by Humphry's patent hydraulic steering gear. The weight of coals, water, stores, and ballast on board during the trial on the 18th ult. was 793 tons, and the vessel's draught of water was 18ft. 5in. forward, and 18ft. $4\frac{1}{2}$in. aft. The *Carnatic* made four runs at the measured mile in Stokes Bay with the following results:—1st run, 5m. 9s., equal to 11·650 knots per hour, $71\frac{1}{2}$ revolutions; 2nd run, 3m. 54s., equal to 15·384 knots, 71 revolutions; 3rd run, 4m. 47s., equal to 12·543 knots, 72 revolutions; 4th run, 3m. 50s., equal to 15·652 knots, $72\frac{1}{2}$ revolutions; pressure of steam, 26lb.; vacuum, 28; force of wind, 4, E.N.E. to S.S.E. The true mean of the four runs was 13·885 knots per hour. The first and third were against wind and tide, and the second and fourth with. The engines, which are of 400-horse power nominal, indicated 2442 during the trial, being over six times; whilst four times the nominal horse-power is generally considered good for a new vessel. She has 168ft. of firebar, so that the result showed no less than 14-horse power per foot of firebar; whilst Her Majesty's ship *Warrior*, on her trial trip, realized $6\frac{1}{2}$-horse power per foot of bar, the difference being the true measure of the economy of fuel.

Trial Trip of the Steamer "Roman."—The new screw steamship *Roman*, one of the fleet of the Union Company, which carries on the mail service between this country and the Cape of Good Hope, underwent an official trial on the 23rd ult., at the measured mile in Stokes Bay, prior to leaving with the outward May mails. This vessel, which is the seventh built for the company by Mr. Charles Lungley, of Deptford-green Dockyard, is the second he has constructed on his unsinkable and fireproof principle. A watertight trunkway is carried from each lower deck to the upper deck, so that in the event of water getting into either of the bulkheads it cannot rise throughout from deck to deck, as in ordinary ships, but can only rise in the watertight trunkway, the rest of the vessel being kept buoyant and free from water. The dimensions of the *Roman* are as follows;—length over all, 279ft. 10in.; length between perpendiculars, 268ft.; breath of beam, 32ft. 3in.; depth of hold, 26ft.; registered tonnage, 1027 tons. The engines, constructed by Messrs. Day and Co., of the Northam Ironworks at Southampton, and laid horizontally, are of 220 nominal horse power, giving out an indicated power of 973, and are fitted with the modern improvements for saving fuel,—viz.. superheating apparatus, surface condensers, and steam jackets to the cylinders. The results of four runs at the mile were as follows: 1st run, 5 min. 4 sec.. equal to 11·841 knots per hour, 74 revolutions; 2nd run, 5 min. 8 sec., equal to 11·688 knots, 72 revolutions; 3rd run, 5 min. 26 sec., equal to 11·043 knots, $75\frac{1}{2}$ revolutions; 4th run, 4 min. 44 sec., equal to 12·676 knots. $75\frac{1}{2}$ revolutions; pressure of steam, $22\frac{1}{2}$lbs.; vacuum, 26in. The true mean of the four runs was 11·588 knots, to which the surveyors add a third of a knot to compensate for the adverse influences of the wind, which was blowing strong throughout from the north-west, with a force of 5 to 7. The vessel's draught of water was 14ft. 5in. forward, and 15ft. aft., and she had 470 tons of coals and stores on board. The *Saxon*, a sister ship to the *Roman*, and which is now making her maiden voyage out to the Cape, was built and engined by Messrs. Day and Co., the engines for the *Roman* being the ninth pair constructed by that firm for the Union Company. This Company has the longest steam line in existence, and as an instance of the test to which the machinery of these Cape steamers is subjected, it may be mentioned that on her last voyage the *Briton* made the run from Plymouth to Table Bay in 32 days 19 hours, during which time her engines were not once stopped, and thus made by the counter 2,644,320 revolutions without cessation.

Iron Shipbuilding on the Diagonal Principle.—An iron clipper ship, called the *Sydney Eggers*, and built on Taylerson's patented diagonal principle, is at present to be seen in the Wapping Dock, Liverpool. The principle adopted by Mr. Taylerson, and for which he has obtained a patent, is widely different from that now employed by shipbuilders. In the ordinary construction the frames are placed vertically, and parallel to each other, the frames being secured to the outside skin by rivets in a direct vertical line from the gunwale to the keel on each side of the vessel. This plan, Mr. Taylerson contends, is a source of weakness, springing from two causes—first, the frames, being in a vertical direction and parallel to each other, cannot offer sufficient resistance to any force or strain having a tendency to tear the ship asunder; and, secondly, the frames being secured to the outside shell by rivets running in a vertical line from the gunwale to the keel entail one continuous line of weakness in that direction. The leading features of the diagonal plan, as described by the inventor, are these:—"That in the case of the vertical principle the line of resistance to any force acting in the direction of the vertical planes of the ship will be in a line with the shortest circumferential line of the body of the ship, thereby opposing the least amount of resistance to fracture coming in the direction of these planes; whereas, in the case of a ship built in accordance with my diagonal principle the line of resistance to forces acting in the direction of these vertical planes be diagonal to the circumferential line of the body of the ship, thereby opposing the greatest amount of resistance that can be given to an angle equivalent to the inclination of the frames. The same argument and the same reasoning apply to the perforations in the plates, or outside skin, which, running in the same vertical line with the frames, as already described, produce a series of lines of inherent weakness in the structure of the ship, and which I propose to remedy by my patented mode of making the line of junction of the butts of the plates diagonal instead of vertical, as in the present mode of construction." In connection with the diagonal framework Mr. Taylerson's introduces bulkheads on a new construction, and also a hollow keel and keelson, all of which afford increased strength and security to the vessel. The ship *Sydney Eggers* affords an illustration of the patent. She is a handsome vessel, of 847 tons register, with extensive carrying capacity. In a report from Mr. R. Thornton, civil and practical engineer, Edinburgh, he states that to tear assunder a ship on the vertical principle, size and weight of metal being the same as Taylerson's, a strain would be required equal to 11,610 tons weight at each end; whereas on the diagonal plan it would bear a strain equal to a weight of $23,152\frac{1}{2}$ tons without any injurious effect on the vessel.

LAUNCHES OF STEAMERS.

Launch of the "Marco Polo" Mail Steamer.—On the 9th ult. Messrs. W. Simons and Co., London Works, Renfrew, launched a very handsome new passenger paddle-steamer for the mail service of 750 tons, and 250 horse-power. She was christened *Marco Polo* by J. Beaumont Neilson, Esq. The engines were also manufactured at the London Works, and were started and worked on board.

Launch of Steamers on the Clyde.—The Clyde builders continue exceedingly well employed. Messrs. Henderson, Coulburn, and Co., of Renfrew, have launched a screw named the *William de la Rue*, 177ft. in length, 24ft. 6in. in breadth, and 13ft. in depth, with engines of 90-horse power on the diagonal oscillating principle. She has been built for Mr. H. S. Seligmann, of Glasgow, and is to be devoted to the Bordeaux trade; her builders are now engaged on a sister vessel for the same line, which is nearly ready for launching. Messrs. W. Denny and Brothers have launched a screw of 2000 tons, built for Messrs. A. Lopez and Co., of Alicante, and intended for the Spanish line of mail steamers between Cadiz and Havannah. She has been named the *Principe Alfonso*, and is now being fitted by Messrs. Denny and Co. with engines of 400-horse power.

TELEGRAPHIC ENGINEERING.

Submarine Cable in Lough Foyle.—Mr. B. D. Watlock, chief engineer of the Magnetic Telegraph Company, lately submerged a telegraph cable in Lough Foyle, by means of which from two to four hours will be saved in the transmission of despatches by the Canadian steamers.

Submarine Telegraph Communication—Duncan's Ratan Cable.—The strength of this cable has been carefully tested, and given satisfactory results. A copper wire of seven strands, the combination being about $\frac{1}{8}$in. in diameter, is surrounded with a protecting covering of India rubber, or other suitable material, and the canes are then laid spirally round, as in the ordinary wire-rope cable. It has been found by experiment that a cable so made, and protected with a coating of Duncan's patent compound, weighs but $\frac{3}{4}$ ton to the nautical mile, and will bear a breaking strain of $2\frac{1}{2}$ to $2\frac{3}{4}$ tons, the specific gravity being 1·059. When a single wire is laid with each cane, so as to give additional weight and strength, the weight is raised to 1 ton per nautical mile, and the breaking strain is 4 tons, the specific gravity being 1·288. And when by laying a double wire with each cane the weight is raised to $1\frac{1}{4}$ ton per mile, the breaking strain is from 6 to $6\frac{1}{2}$ tons and the specific gravity 1·54. Mr. Duncan states that in the last two instances floatation and gravitation are excellently and mechanically united and balanced. With regard to the joining of the canes, he tells us that some doubts have been expressed as to the practicability of effectually and strongly joining the canes, he is desirous of stating that the joints are made very easily and simply, and on being tested they have been proved to be as strong, or even stronger, that the canes themselves. The joints will be arranged to fall at intervals and break joint, so as to secure the maximum strength. It is considered that although ratan cane is most peculiarly and strikingly adapted for deep water cables, yet by its wonderful durability in foul mud, and other usually destructive influences, it is not less valuable as a protection to the heavy metal sheathing of shallow water cables.

Extracts from Dr. Odling's Report on ratan cane.

"The entire cane yields 8·03 per cent. of ash, having the following composition:—

Silica	76·04	Soda	6·86
Sulphuric acid	7·36	Lime	2·37
Potash	7·30		
Total			90·93

with traces of iron, manganese, magnesia, and phosphoric acid. The outer portion of the cane, sliced off with a knife, yields 40·04 per cent. of ash, of which 97·07 per cent. is silica. The remainder of the cane, from which the exterior had been sliced off, yields 2·40 per cent. of ash, of which 28·26 per cent. is silica. The substance of the cane is made up of cellular tissue, with irregularly interspersed bundles of woody fibre, or more correctly, of fibro-vascular tissue. The cuticle of the cane consists of flattened closely adherent cells, filled with silica, so as to form a complete siliceous sheath to the whole."

RAILWAYS.

The East India Railway, which was begun in 1851, has been carried on at the rate of 90 miles a year, and is completed from Calcutta to a point near Delhi, with the exception of 140 miles.

Railway through Greenwich Park.—Two reports, one by Prof. Airey, the other by Admiral Washington, on the above line of railway, which has lately been proposed, have been just published. Admiral Washington says:—" I have read the report of the Astronomer Royal, giving the result of some former experiments on the vibration caused by the passage of a railway train at the distance of 1000ft., and I am of opinion that their lordships should withhold their assent to any line of railway that passes within that distance of the Royal Observatory. No doubt the accommodation and convenience of the travelling public should have every consideration, but with all due deference it must not be allowed to interfere with the high character that the astronomical observations made at Greenwich have hitherto borne. Of the two proposed railways the London, Chatham, and Dover extension passes within 825ft., and the South London, Greenwich, and Woolwich within 610ft. of the Royal Observatory. I therefore submit that their lordships refuse their assent to both the above bills, and that the Board of Trade be so informed."

METROPOLITAN RAILWAY COMMUNICATION.—The Select Committee appointed to inquire whether any, and, if any, which of the schemes before Parliament for the construction of lines of railway within the limits of the metropolis can be proceeded with in the present session without the risk of interfering with the future adoption of a comprehensive plan of metropolitan railway communication, and to consider what provision can be made for the securing such a comprehensive system, with the greatest advantage to the public, and the least inconvenience to the local arrangements of the metropolis, and to report to the House,—report that the committee have met, and having considered the Bills referred to them according to the terms of the reference, but without any consideration of their merits, they are of opinion that there is no reason why the following Bills should not be proceeded with in the ordinary course.—The Midland Railway (Extension to London) Bill; Barnes, Hammersmith, and Kensington Railway Bill (the agent for the Bill having informed the committee that it is not intended to proceed with that portion of the line between Kensington and the junction with the West London Extension Railway); Hammersmith and City Railway Bill; Victoria Station and Pimlico Railway Bill; Tottenham and Hampstead Junction Railway Bill; London, Chatham, and Dover Railway (No. 1) Bill (with the exception of the Thames Branch); Ludgate Station and Junction Railways Bill; and London, Brighton, and South Coast Railway (Extensions and Alterations, &c.) Bill And the committee are also of opinion that it is not expedient to proceed further with the East London and Rotherhithe Railway Bill; Grand Surrey and Commercial Docks Railways Bill; Metropolitan, Tottenham, and Hampstead Railway Bill; Rotherhithe Railway Bill; and the London Railway (Victoria Section) Bill.

THE LUDGATE HILL VIADUCT.—The secretary of the London, Chatham, and Dover Railway states that the company are willing to construct such a bridge as will, at once, be an ornament to the City, and at the same time facilitate the widening of Fleet-street, so that from the foot of Ludgate-hill, where the bridge crosses, a good view of St. Paul's may be obtained.

THE RAILWAY FROM ROME TO CIVITA VECCHIA.—An accident of a single nature threatens the railway from Rome to Civita Vecchia. It consists of a subterranean flame, a sort of incipient volcano, which has shown itself at the place called Mont-des-Pietres, seven kilometres from Rome. The focus of the flame is on the slope on the right hand side of the railway, in going from Rome to Civita Vecchia. The space occupied by the crevices which give forth the sulphurous exhalations is about 20 metres in length by 10 in width. The temperature of the surface of the soil is remarkably high, so that at certain points it is painful to remain standing for a few moments, even with strong shoes. In penetrating the soil to the depth of a metre, the rock is found to be incandescent, and visibly red in open day. This ignited rock is a clayey slate, rich in lignite and in fossil vegetable deposits reduced to a bituminous state.

THE MONT CENIS TUNNEL.—Mr. Bartlett, an English engineer, set to work a boring machine, by which a tunnel could be pierced with a rapidity eight or ten times greater than any hitherto obtained by ordinary means; but Mr. Bartlett's contrivance was wrought by steam, and could not be applied to a tunnel where air could not be had for combustion. The Italian engineers proposed to substitute compressed air instead of steam; and, notwithstanding long opposition on the part of foreign scientific men, their method is now in full operation, and their success exceeded the most sanguine expectations. The tunnel was begun in 1857, with ordinary means. That year and the two following were spent in preliminary operations, such as the construction of houses, workshops, &c., for in that inhospitable regions there was all to be done. The first experiments with the boring machines were made in 1861 at Bardonnéche, on the Italian side; but even on this side the regular work only proceeded uninterruptedly in 1862. The invention of the new machine was yet in its infancy; its occasional failures, and even its gradual improvements, could not fail to cause considerable delays. The tunnel at Bardonnéche, on Jan. 1, 1863, was 1274 metres. In the years 1857, 8, 9, and 1860, 724 metres had been achieved by ordinary means. By the aid of the new machines 170 metres were added in 1861, and 380 in 1862. On the Savoy side, at Modane, from 1858 to Jan. 1, 1863, only the ordinary means were employed, and the result was for the whole of that period only 925 metres. The tunnel, calculating the work achieved at both ends up to the beginning of the present year, has attained a length of 2199 metres, 550 of which have been made with the new machines. What was done at Bardonnéche in 1862, in spite of the imperfection of a half-developed method—namely, 380 metres—must surely be possible in 1863; nay, it is quite certain that the result of the present year will be at least 400 metres. On the side of Modane, again, the new method was applied on Jan. 25 last, and, as there the errors which retarded the work at Bardonnéche will be avoided, the avoided, the result of the work on both sides for 1863 will be no less than 800 metres. The engineers are very confident that the work will proceed with even greater speed, but the Minister would base his calculation on the most certain data, and, by limiting the results of the yearly progress to 800 metres, he thought the whole undertaking would be achieved in 12½ years.

RUSSIAN RAILWAY.—The concession for a railway from Kieff to Odessa has been granted by the Government to a Russian company. The railway will be 647 versts or 429 miles long, with two branches of 300 versts or nearly 200 miles each. The capital will amount to 55,000,000 roubles, or £8,500,000, under a government guarantee of 5 per cent. interest.

RAILWAY ACCIDENTS.

ACCIDENT TO AN EXPRESS TRAIN ON THE GREAT NORTHERN RAILWAY.—An express train on the Great Northern Railway, travelling at the ordinary speed of 40 miles an hour, was nearly dashed to pieces on the evening of the 4th ult., but fortunately no lives were lost, although, most of the passengers were severely hurt. The accident happened close to the Little Bytham station, about seven miles from Stamford. For some distance north of Little Bytham the line runs along a high embankment, which on passing the village itself is elevated above the tops of the adjacent houses. Some 50 yards from the station are a series of what are called "coal drops," by means of which coal trains are unloaded of their contents; the coals passing through openings between the rails to the ground below, whence they are carted away. At this point the line appears to be elevated somewhere about 20ft. above the road below. On a siding over the coal drops stood a number of goods van and cattle trucks at the time of the accident, and to this circumstance must in a great measure be attributed the escape of any of the passengers with their lives. An express train leaves Manchester for London at 3 p.m., and on this occasion consisted of four composite carriages, separated from the tender by a break-van; the rear being brought up by a second break-van, in which was the guard. At 6 o'clock the train had just passed Little Bytham village, and was within about 150 yards of the station, the speed being, as already mentioned, at least 40 miles an hour, when the tire of the leading wheel of the engine suddenly snapped and flew off. The whole train immediately left the main line, ploughed up the ballast, and rushed through the metals of several sidings. The engine struck the first of the vans standing over the coal drops before mentioned. Most of the cattle trucks and goods vans on the siding were completely shivered to fragments, the woodwork being detached from the wheels and strewn all around; strong telegraph poles were snapped like slender reeds, and to add to the confusion the wires rendered temporarily useless for communication; the engine and tender were doubled up in a way which plainly indicates the terrible force of the collision, while the carriages of the train were shattered and piled about the embankment in a state of ruin which rendered it apparently hopeless to expect that any of the passengers could be found alive. One of the carriages, containing several persons, occupied a most extraordinary position; the wheels at one end were resting across the metals on the verge of the embankment, while the other end was supported by the telegraph wires, and thus prevented from falling a considerable depth.

ACCIDENT TO AN EXPRESS TRAIN.—On the 21st ult. the express on the Great Western line which left Birmingham for Birkenhead at 8.55 suddenly broke down on the Bradley embankment. The train was running at about 30 miles an hour, had not stopped since leaving Birmingham, and had above three miles to run before it would reach its first stopping station at the entrance to Wolverhampton. When the train was nearing the Bradley-bridge the engineer was alarmed by a violent jerk among the machinery of the engine, which immediately afterwards began, in the words of the engineer to "roll about very much." but it did not leave the metals, and was brought to in about 300 yards. It was then found that the massive crank axle of the engine had broken at the big end journal of the connecting rod, where it is about 11 inches across, and about 4 inches in thickness. The driving-wheel at this end of the axle thus becoming liberated, it fell between the flange of the rail and the timber and broke off a part of the splasher, and to this extent happily the accident was confined. There were about six carriages in the train, with the ordinary complement of passengers, who escaped all injury. The train which was dated out of Birmingham five minutes after the express left was kept back by the prompt action of the officials in charge of the train, who hastened to Wednesbury and had the usual signals put up, after themselves placing the fog signals upon the rails.

BOILER EXPLOSIONS.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.—At the ordinary monthly meeting of this Association, held the 31st March, the Chief Engineer presented his monthly Report, of which the following is an abstract:—"During the past month, there have been examined 370 engines—1 specially; 492 boilers—6 specially, 17 internally, 60 thoroughly, and 409 externally, in which the following defects have been found:—Fracture, 2 (1 dangerous); corrosion, 18 (2 dangerous); safety valves out of order, 4; water gauges ditto, 24; (1 dangerous); pressure gauges ditto, 16; feed apparatus ditto, 5; blow-off cocks ditto, 47 (1 dangerous); over-pressure, 2; deficiency of water, 2; blistered plates, 2. Total, 130 (6 dangerous). Boilers without glass water gauges, 1; without pressure gauges, 1; without blow-off cocks, 36; without back pressure valves, 58. Two explosions have occurred during the past month to boilers not under the inspection of this Association, by which 15 persons were killed, and 16 others injured, making a total of 31. Both boilers have been personally examined subsequent to the explosion. No. 4 explosion occurred at an ironworks to a boiler connected to a series of eighteen others. It was very similar in general construction, though not precisely so, to those known as upright furnace boilers, like which, it stood erect, was of considerable height, and surrounded with brickwork. The top of the boiler was hemispherical, and the bottom flat; whereas, in the ordinary furnace class, both ends are hemispherical, which is an important difference. The boiler was 20ft. high, and about 9ft. 6in. diameter. The internal fire-box was 10ft. high, 4ft. 6in. diameter at the crown, and also for about the first 3ft. 6in. below; from which point it tapered outwards to a diameter, at the bottom, of 6ft. 6in., leaving an annular water space all round, about 18in. in width, between it and the shell. This fire-box was united to the shell at the bottom, by a flat plate connected by rings of angle iron inside the water space. The crown of this internal fire-box was slightly domed, and flanged at its attachment to the cylindrical sides, being amply stiffened by six angle irons laid across and well rivetted to it. At the upper part of the fire-box were the two outlets previously referred to, and which were formed by short transverse flues passing through the water space, and thus establishing a communication between the internal furnace and the external flue. These short flues, which were opposite one to the other, and at right angles to the furnace door, were 2ft. 6in. in diameter, and attached by rings of angle iron at each end. The thickness of the plates was: in the hemispherical end and cylindrical sides of the external shell, three-eighths of an inch; in the flat plate at the bottom of the water space, seven-sixteenths; while all the angle irons were 3in. by 3½in. thick. In the fire-box, the thickness of the crown plate was half an inch, and that of the sides seven-sixteenths. With regard to the lay of the plates, that in the shell was according to the usual plan, being radial in the hemispherical end, and circumferential in the cylindrical sides, the seams in the latter breaking joint; while, in the taper-portion of the fire-box, the plates were laid longitudinally, and thus, which it is important to notice, the seams were in line for a length of between six and seven feet. The riveting was single throughout, and the seams were the ordinary overlap. The boiler had been fitted with a float, two gauge taps, one feed stop-valve, one feed back-pressure valve, and one lever safety-valve of 5in. diameter, which was loaded to a pressure of nearly 50lb., and at all events would have allowed the steam to have reached that pressure when blowing off freely. Also there were two junction valves, one of which was in the steam-pipe communicating with the entire series of boilers, and the other in that connected to the steam-hammer. There was no steam pressure-gauge on the boiler itself, but one was fixed to the main steam-pipe beyond the junction valve, and thus afforded no indication of the pressure of the steam within the boiler, when it was shut off from the others in the series. Both of the junction valves were closed at the time of the explosion, and thus the safety-valve formed the only outlet for the steam. What the pressure then rose to cannot now be ascertained, the steam-pressure gauge, as just pointed out, giving no indication under such circumstances. The safety-valve, however, was found to be free after the explosion, and there is no reason to conclude that it had been otherwise previously. But it is apparent, from this, how circumstances will arise which make it important that every boiler should be fitted with a duplicate safety-valve, as well as with its own independent pressure guage. A serious oversight had been made in the design of the boiler, the top end being hemispherical and the bottom flat. The hemispherical end would, when the steam was fully up and blowing off freely, have an upward pressure of nearly 250 tons acting upon it and tending to tear it away from the bottom. There would be an equal downward strain counteracting this, induced by the pressure of the steam upon the crown and tapering sides of the fire-box, combined with that upon the flat plate forming the bottom of the annular water space. As long as the attachment between the bottom and the top of the boiler held good, the two forces would be held in equilibrio, and the boiler remain at rest upon its bed. But should the attachment fail, the upward force would instantly shoot the top of the boiler up into the air with a buoyancy of 250 tons, which, it may be remarked, is equal to the weight of a long railway train, including the engine and tender fully equipped with coke and water. This action is exactly what took place. The flat plate at the bottom gave way, rending completely round through the seam of rivets, at the outside ring of angle iron which attached it to the shell; when the boiler flew up and was carried to a distance of 160 yards from its original seat. The brickwork at the top of the chimney was shaken, and there were marks of violence on the crown of the boiler, so that it is possible that it struck the top of the chimney in its course. There is nothing surprising in this, when the amount of the pent-up force of steam within so large a boiler is considered, and the due appreciation of which shows how unnecessary is the supposition of the existence of explosive gaseous compounds, or any force greater than that of the steam itself; while the propagation of such theories only tends to divert attention from the real cause of steam boiler explosions. The rent at the flat bottom plate, however, was by no means the only one that was made. The short transverse flues passing through the water space, and which considerably assisted the bottom plate, also gave way, and were torn from both the shell and fire-box, their mode of fracture giving unmistakeable evidence of the upward flight of the shell. The resistance of these flues to fracture had severed the fire-box in the waist at the ring seam of rivets, at which the longitudinal plating terminated; and thus the fire-box crown, as well as one ring of plates with the two short flue tubes, had flown up together with the shell, which made a somewhat remarkable and complicated feature in the development of the rents. Added to this, the remaining portion of the fire-box, which was taper, and plated longitudinally, rent at one of the longitudinal seams opposite the fire door, and collapsed at that part. No. 5 explosion occurred to one of two mill boilers working side

by side and connected together, both being of the plain double flued, internally fired class, termed "Lancashire." The length of the one in question was 28ft., the diameter of the shell 10ft., and that of the flues, which were parallel throughout their whole length, 3ft. 9in., the thickness of the plates was seven-sixteenths in the shell, and three-eighths in the flues. The boiler had been fitted with one glass-water gauge, one feed back-pressure and stop-valve combined, one blow-out tap, one lever safety-valve, and one Schæffer steam pressure-gauge, common to both boilers. The pressure at which the safety-valve was stated by the engine attendant to have blown off, was 30lb. on the square inch, which an examination of its dimensions, levers, and weights corroborated. On examining the boiler it was found that the right hand flue had collapsed from one end to the other, and by the flattening action had become severed completely in two at some of the ring seams of rivets, as well as torn away from the end plate at the back of the boiler. The boiler had not stirred from its original position, and the connections to the one alongside remained unbroken. The rush of water, however, from the opening at the back, had blown up the brick flue and carried away the end wall of the boiler house, in consequence of which a floor above, as well as some cast-iron girders by which it had been supported, were brought down. It was by the fall of the building that the three men received their injuries, one of whom was found to be dead when dug out of the *débris*. At the front end of the boiler the furnace mountings had been blown off. With regard to the cause of the collapse, there was no evidence of "shortness of water," judging from the appearance of the plates; added to which, the other furnace in the same boiler remained unaltered in shape, which could not have been the case had deficiency of water occurred; while, in addition, it appeared that the collapse of the flue had commenced at the middle of its length, and not over the furnace, where the shape was less distorted than at any other part. The collapse cannot be fairly attributed to "shortness of water," but its true cause will be found in the construction of the flue, which was not strengthened with flanged seams or the addition of any hoops. Such a flue as the present, of so large a diameter at 3ft. 9in., and 28ft. long, made of plate only three-eighths thick, is not safe for regular work with steam at a pressure of 30lb. per square inch, as was the case in this instance. It might work for a time, but still there would be a risk, as the event proves; a rise that might have been avoided had the flue been strengthened with any of the approved methods, namely, flanged seams, or hoops, either of angle-iron, T iron, bridge rail section, or any other suitable form; to the importance of adopting which attention has been called, it is feared with tedious frequency, though an apology for so doing, it is thought, may be found in the frequent occurrence of such explosions as the present, and in the loss of life consequent upon them. It may here be added, there is every reason to conclude that the boiler in question was an illustration of the danger referred to in previous reports, arising from internal flues being actually oval, although supposed to be circular. The angle iron rings at the end plates were circular, but the inclination of the axis of the collapse of the flue indicated that the middle portion had been oval. The other flue alongside was evidently so, and had, in consequence, been strengthened by two stays attached to the crown. The flues of all the boilers under inspection of the Association are guaged to ascertain their actual shape, when the members allow an opportunity of making "thorough examinations," without which it cannot be done; and very numerous are the instances in which flues, previously supposed to be circular, are found on actual measurement to be oval.

Boiler Explosion near Glasgow.—At an early hour on the 8th ult. a boiler explosion, resulting in serious loss of life, occurred at the Mossend Ironworks, near Holytown, a station on the Caledonian Railway, about 13 miles from Glasgow. The works in question, which are the property of the Mossend Iron Company, cover nine or ten acres of ground, and comprise several large sheds occupied by forges, together with an extensive rolling mill. The machinery in these two departments was driven by separate engines, these again having each its own set of boilers, and it was to the boilers connected with the rolling mill that the accident occurred. These boilers were five in number, and were placed side by side on a solid foundation of brick, their ends pointing towards the north and south. They were all 25ft. in length, and four of them, which were egg-end boilers, were 5ft. in diameter, while the fifth, a flue-boiler, had a width of 6ft. The fire-hole extended along the south ends of the boilers. Beyond this is a tramway, on which some coal-laden trucks were standing at the time of the accident, and south of this again stands the rolling mill. On the west side of the boilers, at a distance of about 20 yards, are the forges, and on the east side, about double the distance off, is an engineer's shop. The chimney which carried off the smoke from the furnaces stands on the north-west corner of the square site which the boilers occupied. At the time when the accident occurred—2 o'clock in the morning—there were upwards of 300 men engaged in the works, the greater portion of them being dispersed through the forges and rolling mill in the immediate neighbourhood of the boilers. At the hour mentioned the whole neighbourhood was alarmed by a crash, followed by a shower of bricks and other débris, which flew in all directions to a distance of 300 or 400 yards. On repairing to the spot, it was found that the site formerly occupied by the boilers presented a yawning crater, the force of the explosion having completely torn up and scattered to a distance the mass of substantial brickwork. As for the boilers, one with both ends blown out lay along the tramway to the south of the firehole, where it had thrown down the chimneys of two of the rolling mill furnaces; the greater part of another lay a little further to the south, among the ruins of the rolling mill sheds; a third had been precipitated about 30 yards to the northward of its bed, where it lay in the shape of a huge spiral riband; while the remaining two had been hurled northwards quite out of the works, and alighted in a field at a distance of about 250 yards. Besides these ponderous masses, domes, ends, and other fragments of boilers had been thrown to great distances both to the north and south. One large piece, weighing about two tons, had flown across the turnpike road on the south side of the works and alighted in a field at 300 yards' distance. The roofs of the rolling mill sheds were completely destroyed by the falling débris, and those of the forge sheds and the engineer's shops suffered considerably. Of the persons employed in the neighbourhood of the boilers seven were either killed on the spot, or so severely injured that they did not long survive the accident; while several others were more or less hurt.

WATER SUPPLY.

Water Supply of Paris.—Among the numerous advantages bestowed on the inhabitants of Paris within the last few years is to be reckoned a good supply of pure water. Paris now receives, from various sources, a volume of water equal to 153,000 cubic mètres daily, of which the canal of the Ourcq supplies 105,000 cubic metres. This water is distributed by means of 20,948 mètres of pipes for the supply of houses, and of 754,852 mètres of pipes for the supply of the public, of which the diameter of the largest is not less than one mètre ten centimètres. Two steam pumps are being constructed on the Quai d'Austerlitz, of 100-horse power each, which will increase the present supply of water by from 12,000 to 15,000 cubic mètres the day. Taking the present daily supply of 153,000 cubic mètres, this is equal to 33,660,000 gallons, equal to about 20 gallons per head of the present population of Paris within the fortifications.

GAS SUPPLY.

Gas in Paris.—The annual meeting of the Paris Company for lighting and heating by gas has recently been held. The dividend declared was at the rate of 17 per cent. per annum, the profits realised in 1862 having been £1,200,000.

The Sheffield United Gas Light Company announces a reduction in their price of gas from 3s. 9d. to 3s. 6d. per 1000 feet—a reduction which also involves the payment of a dividend of 10 instead of 8 per cent.

The Gas Committee of Wolverhampton have presented a report to the Town Council, in which the following is found. "The Company charge the Corporation with a consumption of 18,000 cubic feet of gas for each annual lamp. This calculation is made on the basis of the original contract to supply five cubic feet per hour for 3600 hours. For the lamps which are burned only eight months in the year 14,000 cubic feet of gas is charged for 2800 hours." A reference to the following towns will show that the charges paid for lighting the lamps are considerably less than Wolverhampton, for while there the price is £3 12s. 6d., it is in Ashton-under-Lyne, £1 4s. 1d.; Bath, £3; Birmingham, £3 10s.; Blackburn, £2 2s. 9d.; Bolton, £1 8s. 3d.; Bradford, £2 8s.; Bury, £1 8s. 2d.; Coventry, £2 10s.; Derby, £2 6s. 2d.; Preston, £2 16s. 7d.; Salford, £2 2d.; Dudley, £3; Leeds, £2 5s.; Manchester, £1 5s.; Sunderland, £2 15s. 6d.; Warrington, £2 14s.

CANALS.

Indian Canals.—The Indian Government has sanctioned the excavation of a canal through the Richia Doab, with its head near Aknoor, or at the confluence of the Chenab and the Tavoy.

DOCKS, HARBOURS, BRIDGES, &c.

Proposed Harbour Defences at San Francisco.—The Adjutant-General of the United States army, in command of the California department, proposes for the defence of the entrance to the Harbour of San Francisco (the "Golden Gate"), the construction of two iron-plated towers, one on Point Bonito, and another on Point Lobos (on both sides of the entrance to the Bay of San Francisco), and, if necessary, another still in the middle of the passage. These plated towers are to rest upon a foundation of masonry, to have dome-shaped revolving roofs or turrets, and to be pierced for two tiers of guns, each tier to mount thirty guns, and the foundation provided with casemated guns. Across the throat of the harbour from fort to fort could be placed a series of massive chains, attached to windlasses moving by steam engines in the forts, which would also revolve the turrets (or roofs) containing the batteries; these chains to be drawn up by the windlass, when required, to such a deflection as to prevent the passage of vessels. This would check the momentum of the vessel, and it would be at point-blank range under the fire of two forts, each capable of delivering a shot every second. As the turret (or tower, or roof, as the upper works are indiscriminately called), revolves, each gun in its turn is brought to bear upon the object direct, and the revolution is made in one minute if desired.

A Wet Dock for Jersey.—In the report issued by the Chamber of Commerce, it is stated that there is every reason to believe that the project for the construction of a wet dock at St. Helier's is about to be carried out. The cost of the wet dock, including a graving dock, is set down at £85,000.

Commercial Harbours.—A parliamentary return recently issued gives the following details of £450,000 estimated for commercial harbours. The estimate is for the coast batteries designed in accordance with the special requirements of each these, viz.—Humber, £70,000; Tyne, £20,000; Sunderland, £20,000; Yarmouth, £10,000; Lowestoft, £10,000; Ramsgate, £6000; Dungeness, £10,000; Poole, £6000; Torbay, £6000; the Severn, £40,000; Swansea, £8000; Holyhead, £25,000; the Mersey, £40,000; the Clyde, £40,000; Aberdeen, £12,000; the Tay, £10,000; Firth or Forth, £40,000; Kingstown, £7000; Belfast, £14,000; Galway, £15,000; Shannon, £10,000; sundry harbours, £30,000—giving a total of £450,000.

New Blackfriars Bridge.—The Committee have duly passed the bill.

MINES, METALLURGY, &c.

Nickel.—Mr. Lewis Thompson, M.R.C.S., in regard to this metal, states, in a recent paper, as follows:—There is every reason to suppose that metallic nickel is an alloy of that metal with cobalt in greater or smaller proportion—that, in fact, absolutely pure nickel has not hitherto been obtained. Pure nickle is, however, much more easily made than pure cobalt, for its affinity for oxygen is much less. Taking advantage of this fact, I made up a quantity of pure oxide of nickel into a paste by means of a little water, and forced this paste through a perforated earthenware plate, so as to form it into a granulated mass; when this mass had been thoroughly dried, I introduced it into a porcelain tube, and after heating it red-hot, I passed a current of pure hydrogen gas over it, and continued this until it had become cold. The grey metallic sponge thus produced was fused with a little borax, in a crucible lined with pure alumina, and yielded a beautiful white silvery-looking button, of the weight of 620 grains; its specific gravity was 8·575, and it was almost as soft as copper. Its malleability seemed very great indeed, for a piece of it was rolled out nearly to the thinness of tinfoil; it showed, however, a disposition to tarnish after a few days' exposure to the air, and then became of a pale yellow colour—a kind of green-sickness tinge. Its magnetic properties were less decided than those of either cobalt or iron; and, judging by the globular form and other evidences of perfect fusion in the button, I believe that nickel is much more fusible than the two just mentioned. When portions of it were melted with copper and zinc, in the quantities usually adopted to form albata, it produced a compound vastly superior in appearance to any of the miserable make-shifts that now disgrace our markets. Indeed, I am quite convinced that it would well repay any respectable person to commence the manufacture of pure nickel, and it would not surprise me if a compound of aluminium and nickel could be formed which, for beauty of appearance, might equal silver, and surpass it in durability and freedom from sulphurous deterioration. Whilst alluding to the advantages of an improvement in the manufacture of nickel, it may not be amiss for me to notice two points of some importance in the way of improvement. At present the extraction of nickel from the ore is made to depend very much upon the affinity of arsenic for that metal, so as to form with it an arseniuret of easy fusibility and sufficient specific gravity to separate freely from the melted slag or gangue; and for this purpose large quantities of arsenic are employed by the workmen, not only to the detriment of their own health, but also to the injury of their neighbours. This pernicious practice is quite unnecessary, as I have myself proved by experiments upon a large scale; for example, after carefully roasting six hundred-weight of the common ore of nickel, which is an arsenio-sulphuret, I mixed it with half its weight of chalk, and threw the mixture into a cubilo furnace in full blast; the result was that the lime of the chalk formed, with the quartz and oxide of iron in the ore, a perfect flux; whilst the oxide of nickel, being easily reduced to the metallic state, fell, in that condition, into the well of the cubilo, from whence it was run out in a melted form, and readily separated from the slag. There was no appreciable loss of nickel in this operation, and the rough metal was found to contain 88 per cent. of pure nickel, the rest being cobalt and iron, with a little sulphur, but no arsenic could be detected in it; moreover, this rough metal might, from the cheapness of the process, have been sold at 3s. per lb., and was decidedly more pure than the ordinary commercial nickel. The other point to which I have alluded is applicable to the wet mode of separating nickel, and depends upon a fact hitherto, I believe, unnoticed by chemists. If we have in solution a mixture of the sulphates of nickel, cobalt, zinc, manganese, iron, and copper, we have only to add to this solution, in a warm state, as much sulphate of ammonia as it will dissolve, and then set it aside to cool. Almost every particle of the nickel and cobalt will separate as a green crystallised powder, and leave the other metals in solution. The explanation is very simple. The sulphates of nickel and cobalt form triple salts or alums with the sulphate of ammonia, and these salts are absolutely insoluble in a cold saturated solution of sulphate of ammonia, particularly when this solution is slightly acidulous. I shall conclude these remarks upon nickel by stating that this metal appears to possess the property of "welding" like iron. At my request a workman heated two small bars of nickel, which had been previously powdered over with borax, the bars were heated in a forge, and the two hot ends "jumped" together—that is to say, the white-hot ends were forcibly driven one against the other by gentle blows with a hammer, applied to the other

ends, the symmetry of the bar being preserved by blows applied laterally. Although the point of junction was afterwards subjected to much twisting, straining, and so forth, with a view to test its cohesive power, yet it showed no signs of weakness, even after much cold hammering.

DIMENSIONS OF THE EARTH'S COALFIELDS.—Professor Rogers states we have it on the authority of competent surveyors, that the great coalfield of South Wales, the largest and deepest in Europe, covers a surface of not less than 1000 square miles, and has a maximum thickness of from 7000 to 12,000 feet in its coal measures. In this prodigious "book of time," there are, it has been commuted, not less than 50 beds of coal, from 6in. to 6ft. in diameter, and 25 of these are said to be each at least 2ft. thick. The smaller Forest of Dean coal basin contains, according to the "Memoirs of the Geological Survey," 31 coal beds in a thickness of coal measures of 2400ft. From the same source (the survey) we learn that the North Staffordshire coal measures have an aggregate depth of about 5000ft.; while those of the Newcastle district are believed to be at least 2000ft. thick, and to embrace a total thickness of coal equivalent to 60ft. In the deepest portions of the extensive coal basin of Scotland, the upper productive coal measures of Mid-Lothian have been found by the survey to possess a thickness of not less than 1800ft. The number of the seams of coal wrought in the Lanarkshire field is in all 18. Turning to other countries, the depths or thicknesses of the coal measures, and the numbers of the coal beds, will be found to be on an equally grand scale. Looking first to the western side of the Atlantic, North America displays, commensurately with the breath of her physical features generally, several enormous coal regions, three at least of which are the largest known upon the globe. One of these, the Appalachian basin, has a length of 875 and a maximum breadth of 180 miles, with an area in square miles of 55,500. Where deepest its coal beds have an aggregate thickness of 40ft. A second, the coalfield of Illinois, Indiana, and Kentucky, has length 370, maximum breadth 200, and area 51,100 miles. This basin has 15 or 16 good coal seams, with a maximum thickness of 50 feet, and the third and largest, but least opened, shows length 550, breath 200, and superficial area 73,913 miles. In the anthracite basin of Pennsylvania the thickness of coal measure, amounts to 3000ft., while that of the workable coal is not less than 120ft. The aggregate area of the five chief coal fields of the American continent amount by careful estimates based upon the latest surveys and the best geological maps, to rather more than 200,000 square miles; a surface greater by about 20 times than the sum of all the coalfields of Europe, or, indeed, of the whole Eastern world. The British carboniferous basins may be estimated to embrace some 5400 square miles of coal; the French a little less than 1000; and the Belgian about 510. Rhenish Prussia has 960; Westphalia 380; the Bohemian field some 400; that of Saxony only 30; that of Spain probably 200; and that of all Russia scarcely 100 square miles. Comparing the coal areas with the total surfaces of the respective coal producing countries, the United States has one square mile of coal to each 15 of land; Great Britain one to every $22\frac{1}{2}$; Belgium a like proportion; and France but one of coal to every 200 of country. Adopting for the commuted total area of the coalfields of the world 220,000 square miles, and accepting 20 feet (a low estimate) for the average thickness of the available coal, the entire mass of the fuel under the soil for the future wants of man amounts by calculation to a cubic lump of nearly ten miles lineal dimensions, or to a square plateau of coals 100 miles wide in its base, and something more than 500ft. in height. The British lump of coal is a cube of a little more than three miles in diameter. In 1854 Great Britain extracted from her mines more than 64,000,000 tons. In 1861 the product was about 80,000,000 tons, equal to a cubic block of 430 yards in height. For the present year the probable product may be safely estimated at not less than the enormous quantity of 100,000,000 of tons. In the preliminary report lately printed on the census of the United States for 1860, it is shown that the coal product of the state of Pennsylvania amounted in that year to about 11,500,000 tons, while that of all the coal yielding states together exceeded 15,000,000 tons. In the year 1850 Belgium took from her mines nearly 6,000,000 tons; France some 4,500,000 tons, and Prussia nearly 4,000,000 tons. It has been calculated that one-fifth at least of the present vast product in coal of the civilised world, which fifth part we may roughly estimate at nearly 30,000,000 tons annually, is applied in the smelting and manufacture of iron alone, and it is probable that more than one-tenth of the whole of the fuel lifted, or some 15,000,000 tons, is converted directly into mechanical power, through the generation of steam for the propulsion of machinery.

LEAD AND LEAD ALLOYS.—It has been generally supposed that the purer a metal, the less it is acted upon by acids; and Messrs. Crace-Calvert and Johnson, in some important researches in connection with lead, considered it very desirable to ascertain, at least, whether the generally received opinion was correct as regards lead. They commenced with sulphuric acid on commercial lead, because that metal is extensively employed in the construction of those large chambers in which sulphuric acid is manufactured; this course combined scientific interest with practical utility. In the experiments which they instituted, they employed sulphuric acid of various degrees of concentration and purity in different volumes at various temperatures, and for various periods of time. They have made use of two kinds of commercial lead, choosing as types the two extremes in respect of purity—common sheet lead representing ordinary impure lead, and virgin or Derbyshire pig-lead. They have also thought it desirable to examine the action of chemically pure lead. The common lead, upon assay, gave—Lead, 98·8175; tin, 0·3955; iron, 0·3604; copper, 0·4026; zinc, traces = 99·9760; and the virgin lead gave—Lead, 99·2060; tin, 0·0120; iron, 0·3246; copper, 0·4374; zinc, traces = 99·9800. At the ordinary temperature (18° to 20° cent.) perfectly pure sulphuric acid of the density stated dissolved from a square metre of surface the following quantities (in grammes) of each kind of lead :—

Density of acid.	In ten days. Common.	Virgin.	Pure.	In fifteen days. Common.	Virgin.	Pure.
1·842	67·70	134·20	201·70	89·00	194·34	279·00
1·705	8·35	16·50	19·70	11·67	16·84	24·00
1·600	5·55	10·34	16·20	6·17	12·17	20·00
1·526	2·17	4·34	6·84	3·17	8·67	10·67

These results leave no doubt that the purer the lead the more it is attacked, and that in a ratio which is very curious and instructive. The result of the fifteen day experiment fully confirms the ten day experiment, and even with heated acid a similar result is obtained. They operated with acid at a temperature of above 45° cent. for eight days, when the result was—

Density of acid.	Common.	Virgin.	Pure.
1·842	418·34	458·50	507·34
1·705	6·84	10·67	13·00
1·600	5·84	6·34	11·84
1·525	3·50	4·84	6·67

The question then occurred to them whether the purity of the acid employed had occasioned such unexpected results. They, therefore, tried other experiments with acid from the leaden chamber (density 15·93), and with acid not as it comes from the leaden chamber, but after having been once evaporated in open leaden vessels, in which its concentration is commenced commercially (density 1·746). The results obtained were—

	Common.	Virgin.	Pure.	Common.	Virgin.	Pure.
A	11·84	15·84	19·50	11·34	16·77	19·84
B	20·17	22·50	27·00	22·17	24·34	27·67
C	49·67	50·84	55·00	51·01	54·75	57·41
D	54·67	56·17	59·34	56·25	58·67	60·67

In the above table the mean results of two distinct series of experiments of each class of 15 days duration are given. In the experiments A, 16·666 litres of 1·593 acid, at a temperature of 45° to 48° cent. was used; in the experiments B, the quantity of acid was doubled, other conditious remaining the same; in the experiment C, 16·666 litres of 1·746 acid, at a temperature of 113° to 122° cent was used; and in the experiments D the quantity of acid was doubled, other conditions remaining the same. The conclusions which Messrs. Calvert and Johnson have drawn from their experiments are—Firstly, that of the various kinds of lead existing in commerce, the purer they are the more they are acted upon by sulphuric acid; lead chemically pure is more acted upon than any of the others. Secondly, that although it is stated in many works on chemistry that sulphuric acid only acts sensibly on lead at a temperature of 195° cent., their experiments tend to prove the contrary, since they find that acid of specific gravity 1·842 dissolves cold 67·134, and even 201 grammes of lead per square metre of surface; and in another instance, that acid of specific gravity 1·705 takes from the same surface 54, 56, and 59 grammes of lead, at a temperature of 45° cent. only; and, lastly, that the action of sulphuric acid upon lead appears, at least when there is no continuous agitation of the mass, not to increase in proportion to the quantity of acid employed—this is probably due to the formation of a layer of sulphate of lead, which, to a great extent, protects the surface from further action of the acid. From the analysis of lead chambers with respect to which they were consulted by a large chemical manufacturer, one which had lasted 15 years, was found to be composed of an alloy of—lead, 98·87; tin, 0·91; iron, 0·12, with traces of copper and zinc; whilst two others, injured in less than one year, contained only traces of tin, the alloy being about 99·4 lead, 0·35 iron, and 0·16 copper and zinc.

APPLIED CHEMISTRY.

ANALYTICAL NOTICES ON URANIUM, BY M. H. ROSE.—Oxide of uranium may be completely precipitated from its acid solutiens, having previously saturated them with ammonia, by addition of hydrosulphate of ammonia. No inconvenience results from the solution containing many ammoniacal salts, excepting, of course, carbonate of ammonia and all alkaline carbonates. The precipitate is black, or reddish brown if the hydrosulphate be greatly in excess. It is washed in water, to which is added a small quantity of hydrosulphate of ammonia. The precipitate is formed essentially of protoxide of uraniam, and contains no sulphide of uranium. After being dried, it is ignited, to expel what little sulphur may be retained; then it is calcined in a hyprogen current, at a high temperature, and left to cool in the hydrogen. Pure protoxide is thus obtained. Should the solution contain much salts of potash, or of other strong non-volatile bases, the precipitate will retain a small quantity of these bases. Oxide of uranium is separable in the following manner from most metals, especially from those which are completely precipitated from their solutions by hydrosulphate of ammonia :—Add to the solution excess of carbonate of ammonia mixed with hydrosulphate. All the oxides which hydrosulphate transforms into sulphides are preciptated, while the protoxide of uranium is dissolved in the carbonate of ammonia. Leave the mixture to deposit in a closed vessel, wash the precipitate by decantation, with water containing carbonate and hydrosulphate of ammonia, and then filter. Gently heat the filtered liquid, to expel most of the carbonate; decompose the hydrosulphate with hydrochloric acid; oxidize the protoxide of uranium by nitric acid, and precipitate the oxide by ammonia, and, before weighing, calcine it in a hydrogen current.

COMPOSITION OF GAS REFUSE BY DR. T. L. PHIPSON.—It has been estimated that one ton of Newcastle coal gives off in distillation as much cyanogen as is contained in five to eight pounds of Prussian blue. As sulphuretted hydrogen is disengaged at the same time in greater or smaller quantities, according to the nature of the coal, it is natural that sulphocyanides should form also. My attention having been lately directed to gas-refuse obtained after eliminating the sulphuretted hodrogen and carbonic acid by hydrated oxide of lime and lime purifiers, I found in this substance certain sulphocyanides, and it occurred to me that it might prove a source of sulphocyanide of ammonium for photograpic purposes. But the samples I have hitherto examined, having been used as long as possible, with a view of obtaining the maximum amount of sulphur, have not promised so much sulphocyanide as I should expect to find in the refuse puriners which had not been employed for so long a period. It is curious to note, however, that this substance, which is offered to manufacturers of sulphuric acid on account of the sulphur it contains, has also been recommended to makers of artificial manures and to agriculturists as a cheap source of nitrogen! It will be seen by the analysis I subjoin that the employment of this substance for agricultural purposes is not only useless, but may become highly injurious to any soil. Besides the cyanogen compounds I have found in it, and which must be considered as prejudicial to vegetation, the existence of tar-products, highly antiseptic, and therefore capable of preventing organic decomposition in the soil—a process indispensable to vegetation—is evident; it contains also a very large amount of free sulphur. When this gas-refuse has been exposed for some time to the air it contains the following substances:—Free sulphur in considerable quantity, oxide of iron, carbonate of lime, cellulose in small quantity, some hydrocarbons soluble in alcohol, double cyanide of iron (green), ferrocyanide of iron (blue), sulphocyanide of calcium, sulphocyanide of ammonium, chloride of ammonium, sulphate of lime, ferrocyanhydric acid (to which the mass owes its acid reaction), and water. Some of these are present in small quantity only, but it is not difficult to put them all in evidence. A rough analysis of the whole has given me :—

Water	14·0
Sulphur	60·0
Organic matters insoluble in alcohol	3·0
Organic matters soluble in alcohol: sulphocyanide of calcium, chloride of ammonium, hydrocarbons, &c.	1·5
Clay and sand	8·0
Carbonate of lime, oxide of iron, &c.	13·5
	100·0

Hot water extracts sulphocyanide of calcium and ammonium, sulphate of lime, and ferrocyanhydric acid. The solution takes a red colour with persalts of iron. Hydrochloric acid disolves a considerable amount of the substance, and the solution obtained is deep-blood red, almost opaque, from the presence of sulphocyanide of iron formed. Alcohol extracts principally sulphocyanides of calcium and ammonium, chloride of ammonium, a small quantity of hydrocarbons, and ferrocyanhydric acid. By evaporating the aqueous solution to dryness, after having added enough carbonate of potash to neutralise its acidity, and treating the residue by alcohol, the ferrocyanhydric acid is left behind as ferrocyanide of potassium, and the alcoholic solution contains only chloride of ammonium and sulphocyanides of calcium and ammonium. By evaporating in presence of an excess of carbonate of potash to complete dryness, and treating with alcohol, the latter takes up principally sulphocyanide of potassium, and by using carbonate of ammonia, in place of carbonate of potash, the alcoholic solution consists of sulphocyanide and chloride of ammonium, which would serve for fixing photographic proofs. The green compound which forms when gas-refuse is exposed to the air, is no other than the double cyanide of iron, $FeCy + Fe_2Cy_3$, discovered by Pelouze, the composition of which corresponds to magnetic oxide. By prolonged oxidation in the air it becomes blue; cold acids have no action on it, but hot nitric acid decomposes it.

A CURIOUS CHEMICAL DISCOVERY has been made by Dissenbacher, a young German chemist. By the addition of a small quantity of chlorine or iodine, pure sulphur is rendered perfectly soft, and the Paris Academy, to whom the the experiment was exhibited by H. Deville, were astonished to see a thin leaf of sulphur treated as flexible as if made of wax.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated March 24th, 1863.

768 H. Cook—Transmitting electric currents and signals for telegraphic purposes.
769 J. Reilly & W. Marton—Lubricating horizontal shafting and bearings of all descriptions.
770 G. Davies—Wrappers or papers for needles, and machinery for sticking needles therein.
771 S. Healey—Zinc.
772 H. Williams—Dressing slates.
773 A. J., & J. Topham—Ornamental twist lace.
774 J. Kirkham—Iron and steel.
775 A. J. Cooke—Portable "Hooka" pipes.

Dated March 25th, 1863.

776 J. White—Protecting the surface of the iron and steel of ships.
777 M. Phillips—Iron or other metallic rod and wire.
778 J. Leach & J. Anderson—Preparing and spinning cotton and other fibrous substances.
779 J. H. Worrall—Producing surfaces in imitation of woods, and in printing therefrom.
780 G. Stuart—Bleaching jute fibre
781 C. Monson—Gravitation engine.
782 R. Armitage & C. Seymor—Stretching fabrics.
783 J. H. Johnson—Zinc.
784 T. Wilson—Uniting earthenware, metal, and other pipes.
785 R. A. Brooman—Cords, ropes, and cables.
786 G. T. Key—Fog and other signals.

Dated March 26th, 1863.

787 L. Christofleau—Fire-arms.
788 R. Mushet—Treating steel and iron prepared by the pneumatic process.
789 G. Cowdery—Making bricks.
790 M. L. Parooll—Construction of locks and adjusting their spindles.
791 N. R. Hall—Weighing apparatus.
792 W. Johnson—Pocket books, purses, wallets, and bill cases.
793 T. Parkinson & J. Wood—Application of embroidery to cotton printed fabrics.
794 W. Tod & R. Paterson—Portable apparatus for working drills and other instruments.
795 G. Davies—Engraving upon metals.
796 J. H. Johnson—Furnaces or fire-places.
797 J. Norton—Projectiles or ignition missiles.
798 W. Blake—Labels for luggage and other articles.
799 F. Applegate—Railway carriage doors.
800 E. Esston—Hydraulic apparatus for lowering full casks and other goods, and raising empty casks or vessels.

Dated March 27th, 1863.

801 J. Grantham—Apparatus connected with machinery used in manufacturing compressed fuel.
802 W. M. Morgan—Coating metals.
803 R. A. Brooman—Scouring wool.
804 J. Taylor—Rain water pipes.
805 W. Clark—Winding or copping frames.
806 J. D. Asquith & G. Greenwood—Rag machines.
807 J. King & T. H. Marshall—Preparing land for seed.

Dated March 28th, 1863.

808 B. W. Goode—Journal, axle, or bearing
809 A. H. Perry—Working railway points, switches, and signals.
810 R. Sims—Reaping and mowing machines.
811 J. Leeming & R. S. Marksdale—Carding engines.
812 A. Blouin & D. N. Mercier—Axletree with linked levers for lifting.
813 W. Symons—Barometers.
814 G. Thomas—Window shutters and blinds.
815 J. Dale & G. Bischof—Aniline, napthylamine, and other analogous bodies.

Dated March 30th, 1863.

816 J. Musgrave—Steam boilers.
817 T. Barnes—Treating fats and fatty oils and volatile oils or essential oils.
818 R. Mushet—Moulds for casting steel or homogeneous iron.
819 H. Hughes—Shaping metal and plastic substances.
820 J. Carver—Carriages employed in machines for the making of lace or other fabrics.
821 W. E. Newton—Process for producing yellow colouring matters.
822 W. Arer—Peeling and decorticating grain.
823 J. Payne—Fire escapes.

Dated March 31st, 1863.

824 E. T. Hughes—Composition for rendering cloth, paper, and similar articles transparent and waterproof.
825 J. Smethurst—Steam engines and boilers.
826 A. B. D. Maurand—Translucid cylindric apparatus for bringing the form r weights and measures into those of the present decimal system most easily and precisely, and vice versa.
827 R. Furnival—Platting or braiding machines.
828 W. Forrest & H. Duckworth—Looms for weaving.
829 A. H. & V. F. Bell—Constructing the armour of vessels of war.
830 R. A. Brooman—Electric telegraph printing apparatus.
831 E. O. Coe—Propellers for ships and other vessels.
832 H. Hsmer—Tanning.
833 J. M. Dunlop—Gining cotton.

Dated April 1st, 1863.

834 J. S. Grimshaw—Carding engines.
835 J. Hindle, W. F. Calvert, & E. Thornton—Looms for weaving.
836 I. Rowland—Mileage apparatus for measuring and registering the distances public vehicles or private carriages travel.
837 J. Bray—Omnibuses, railway carriages, and other vehicles.
838 M. Henry—Lubricating.
839 W. Clark—Preventing fermentation in alcoholic and other liquids while drawing them from their containing vessels.
840 W. West—Working railway signals.
841 W. Mitchell—Coating iron
842 G. T. Bousfield—Steam boilers.
843 E. B. Wilson—Iron and steel and other metals.
844 R. Gavin—Preservation of perishable liquids during the withdrawal or consumption thereof.

Dated April 2nd, 1863.

845 W. H. Phillips—Cleaning the bottoms of ships or other floating vessels.
846 J. W. Law & J. Inglis—Making moulds for casting.
847 E. F. Clarke—Fastening rails for railways.
848 D. S. Sutherland—Protecting vessels of war and fortifications from the effects of projectiles.
849 J. Cassell—Stills for the distillation of petroleum and other heavy oils.
850 J. J. Potel—Furnaces and fire-places.
851 W. Jones—Ships or vessels.
852 G. A. Cox—Preparation and manufacture of jute, hemp, flax, and other fibrous or textile materials.
853 A. P. Price—Fusion, manufacture, production, and refining of metals.
854 A. B. Seithen—Casings, covers, or wrappers for bottles, jars, and other articles.

Dated April 4th, 1863.

855 A. Stewart—Saddles.
856 J. Blain—Finishing threads and yarns.
857 J. P. Hanrez—Drying coal, grain, and other substances.
858 J. Silvester—Attaching guards to pressure gauges.
859 W. H. Perkin—Red and orange colouring matters.
860 W. E. Gedge—Bolting flour.
861 J. Gimson—Actuating shuttles in looms for weaving narrow fabrics.
862 A. V. Newton—Pressure gauge.
863 P. Spence—Sulphuric acid and sulphate of iron.

Dated April 6th, 1863.

864 F. C. Bakewell—Wicks for lamps.
865 B. Cooper—Feeding, scribbling, or carding engines.
866 T. Burrow—Combing or dressing silk, flax, wool, hemp, China grass, or other fibrous materials.
867 W. E. Gedge—Aerial machines.
868 M. Henry—Probes, catheters, and similar surgical instruments.
869 J. Railton—Carding cotton and other fibrous substances.
870 J. Burwin—Pickers.
871 E. T. Hughes—Ornamental tips of parasols, umbrellas, and similar articles.

Dated April 7th, 1863.

872 J. Swinburne & J. Stanley—Steam engines and generators.
873 H. Gilbee—Composition for dressing and preparing silk, cotton, and woollen tissues and fibres, and also mixtures of the same.
874 A. C. Bamlett—Reaping and mowing machines
875 J. Macintyre—knobs and other articles in china and earthenware.
876 J. H. Johnson—Drying grain.
877 J. H. Johnson—Polishing precious and other hard stones.
878 R. A. Brooman—Baryta and its derivatives, obtaining by-products, and revivifying or recovering certain agents employed in such manufacture.
879 R. A. Brooman—Obtaining fac-similes of the veins, pores, knots, and figures of wood upon paper and other surfaces.
880 J. Howard, E. T. Bousfield, & J. Pinney—Steam engines.
881 A. V. Newton—Projectiles for ordnance, and fuses therefor.
882 G. H. & W. R. Hill—Steam boilers.

Dated April 8th, 1863.

883 W. Simpson—Insulating the magnetic needle or needles in compasses.
884 J. Mosheimer—Crushing, grinding, and dressing metallic ores, quartz, and other similar substances.
885 J. N. Brown—Connecting the bearing springs of railway carriages and waggons to the axle boxes of the said carriages and waggons.
886 T. Gray—Preparing and bleaching jute and other vegetable fibres for spinning and other purposes.
887 J. R. Harris—Propelling vessels.
888 W. E. Gedge—Propelling and navigating small craft.
889 W. H. Mitchel—Barometer.
890 J. L. Norton—Washing and drying wool and other fibres and rags, and tentering, stretching, and drying fabrics.
891 A. Kinder—Covering lead or alloys of lead with tin or alloys of tin.

Dated April 9th, 1863.

892 H. B. Fox—Dish covers.
893 D. J. Cooke—Compositions for sizing, stiffening, and colouring yarns and textile fabrics.
894 T. T. Heath—Ceilings.
895 F. J. Risse—Universal haft or handle.
896 G. Spencer—Preventing incrustation in steam engine boilers.
897 A. Hett & F. W. Basset—Preventing the fouling of ships' bottoms, and cleansing the same when fouled.
898 J. Rodley & D. McColl—Preventing the escape of fumes and matters from furnaces.
899 R. K. Penson—Warming railway carriages.
900 J. R. Burton—Cleansing ships' bottoms.
901 G. Feirand—Supplying oil or other liquid lubricant to frictional surfaces.
902 A. V. Newton—Offensive weapon.
903 G. Low—Machinery for boring rocks and other hard substances.
904 A. V. Newton—Stirrups, and the mode of attaching the same to saddles.

Dated April 10th, 1863.

905 G. Colomb—Manufacturing factitious blocks of wood of diversified shades and hues proper for veneering and other purposes.
906 S. A. Couperie—Semi-circular metallic slide.
907 T. Baldwin—Superheating steam.
908 S. Shelmerdine & J. Dransfield—Ornamentation by printing of felt hats.
909 H. R. Spicer—Cases for the enclosure and preservation of human remains.
910 R. Smith—Medicated oil for the preservation of metal, wood, or stone.
911 J. Wightman & C. Dening—Horse rakers.
912 J. Gimson—Screw cutting lathes.
913 H. W. Ripley—Preparing and printing wool and other fibres.
914 H. Caudwell—Vessels of war.

Dated April 11th, 1863.

915 F. Versmann—Moulding machines.
916 J. Lockwood—Steam boiler and other furnaces.
917 D. Mylrea—Fire-bars or furnaces grids.
918 W. Samuel—Improvements in railway carriages to mitigate or lessen the effects of collisions to passengers.
919 J. Farrar—Twisting or doubling yarns of wool or other fibrous substances.
920 W. Clark—Separating ores from their gangues.
921 P. P. Baly—Breakwaters, piers, sea walls, and other similar structures.
922 A. F. Maclore—Looms for weaving figured fabrics.
923 C. A. Collins—Loading carts and waggons with hay, straw, and other similar products.

Dated April 13th, 1863.

924 J. Ramsbottom—Hammering, rolling, and shaping metals.
925 J. Gill—Printing machinery.
926 A. Rolfe—Propelling carriages on railways, tramways, or on common roads.
927 R. Leggett & R. Gittus—Cutting chaff and other agricultural produce.
928 J. Lark—Artificial fuel and cement.
929 R. Reeves—Liquid manure drills.
930 R. Newton—Separating and straightening the fibres of silk waste and other fibrous substances.
931 M. Myers—Trunks, portmanteaus, and boxes.
932 T. Mallison & P. Williams—Opening, cleaning, carding, and grinding or sharpening cards used in preparing cotton and other fibrous materials.

Dated April 14th, 1863.

933 J. Nasmith & S. Thornton—Carding cotton and other fibrous substances.
934 G. Berry—Locks.
935 G. T. Smith—Metallic window shutters.
936 W. & J. Keats—Boots, shoes, or other coverings for the feet.
937 J. Combe & J. H. Smalpage—Machines for winding cops.
938 J. Keats & W. S. Clarke—Sewing machines.
939 H. Trapnell—Vent pegs.
940 R. A. Brooman—Hardening and colouring gypseous limestone and sand and calcareous stones.
941 R. A. Brooman—Lamps for burning light and heavy mineral and vegetable oils.
942 J. Smith—Furnaces and boilers for the generation of steam.

Dated April 15th, 1863.

943 J. Leach—Washing, squeezing, mangling, and and churning.
944 E. P. Colquhoun & J. P. Ferris—Fire bars for the furnaces of steam boilers and fire-grates.
945 T. Gray—Preparing flax, hemp, and other fibres, by which a brilliant lustre is imparted to those substances, and the fibres are separated
946 W. Clark—Apparatus for the transport of goods.
947 H. A. Bonneville—Gas burners.
948 A. Marriott—Boilers for heating buildings, and regulators for the same.
949 W. Spence—Gunpowder.
950 H. Eaton—Presses for baling purposes.
951 J. S. Morton—Locks.
952 A. V. Newton—Blowing apparatus.
953 T. B. E. Fletcher—Apparatus for collecting the solid portions of sewage.

Dated April 16th, 1863.

954 J. B. Watts—Steel sword hilts.
955 J. L. McLay—Mariners compasses.
956 I. Baggs & W. Simpson—Purifying and treating coal gas, sulphuretted hydrogen, and other gases containing sulphuretted hydrogen, and obtaining sulphur, sulphuric and other acids in such treatment.
957 C. Ferrett—Preventing incrustation in steam boilers.
958 S. Moulton—Lessening the recoil of cannon.
959 W. Oldfield—Locks.
960 A. Samuelson—Oil.
961 T. A. W. Clarke—Shuttle driver.
962 F. A. E. Guironnet de Massas—Smut machines, and machines for cleansing and peeling grain and seeds.

Dated April 17th, 1863.

963 R. Knight—Treating and preparing iron, copper, and other wires for telegraphic and other uses for the purpose of preserving them from corrosion or decay.
964 S. Riley—Coca and chocolate.
965 J. & T. Richmond & D. Harling—Looms for weaving.
966 J. Goucher—Steam boilers, and regulating the admission of air into the furnaces of steam boilers.
967 R. C. Clapham—Treating the waste liquor from bleaching powder stills in order to obtain hydrochloric acid and other products therefrom.
968 R. H. Lawson & W. Darlow—Obtaining motive power.
969 W. Massingham—Apparatus for cooling liquids.
970 C. Turner—Felted fabrics.
971 B. J. Webber—Separating corn from the ears, and for combing straw.

Dated April 18th, 1863.

972 C. W. & F. Siemens—Furnaces which are principally applicable to the smelting of iron.
973 W. S. Macdonald—Drying animal, vegetable, and mineral substances.
974 T. A. Weston—Ratchet levers.
975 W. B. Barden—Wheels and axles applicable to locomotives, carriages, and puddle wheels.
976 G. A. Buchholz—Hulling grain and reducing granular substances.
977 T. Hunt—Obtaining motive power.

Dated April 20th, 1863.

978 P. G. Rowell & H. Holt—Securing the bands of locomotive engine and tender springs.
979 C. Randolph & J. Elder—Surface condensers.
980 G., W., and J. Graham—Folding or plaiting fabrics.
981 C. Blanc—Combinator for the purpose of using air and steam as motive power.
982 J. Robey—Separating fluids from more solid matters.
983 W. E. Newton—Lamps.
984 E. W. Hughes—Turn tables, turn bridges, and slips.

Dated April 21st, 1863.

985 A. Ford and R. Rigg—Re-forming and re-using old or waste vulcanized india rubber.
986 H. Raften—Obtaining printing surfaces.
987 J. Heap—Adjustable wrenches for nuts, pipes, and pins.
988 E. L. Simpson—Water-proof compounds.
989 N. P. C. Lloyd—Atmospheric engine.
990 M. Ruukel—Marine steam engine governors.
991 J. W. Nottingham—Two-wheeled vehicles
992 H., E., S., and J. Yeadon—Healds for weaving.
993 H. Donald—Bending or straightening metal platea.
994 W. E. Newton—Wrenches.
995 W. C. Cambridge—Harrows.
996 W. Campion and G. Wilson—Looped fabrics.
997 W. Ryan and W. Daniel—Transmitting, equalizing, and registering human power.

Dated April 22nd, 1863.

998 F. E. Bryant—Ascertaining the temperature of steam and its power of tension.
999 T. Settle—Roving, slubbing, and spinning cotton and other fibrous substances.
1000 F. Durand—Moulding articles of china or other clay or of other plastic materials.
1001 T. Grace—Reaping and mowing machines.
1002 H. B. Barlow—Shoes, boots, and other coverings for the feet
1003 E. J. Jeffs and T. Turner—Carriage ways.
1004 W. Clark—Obtaining publicity.
1005 J. Lee and E. Dawson—Looms for weaving.
1006 G. B. Barber—Steam boilers.

Dated April 23rd, 1863.

1007 J. W. Proffitt and W. L. Duncan—Distributing sand and other substances on the rails of railways and tramways.
1008 J. Whitley, J. B. Pope, and J. W. Burton—Metals.
1009 R. Richardson—Railway permanent way.
1010 W. E. Newton—Repairing worn out files.
1011 W. Clark—Tiles.
1012 T. Richardson and J. C. Stevenson—Sulphate of soda.
1013 P. McGregor—Spinning and doubling.

Dated April 24th, 1863.

1014 J. Cavanah—Cricket bats.
1015 J. B. Daines—Preparation of stone.
1016 W. N. Wilson and J. G. Grey—Sewing.
1017 J. Lambert—Ball cocks.
1018 J. Sheppard—Steam engines.
1019 J. Knowles and S. Jackson—Heating water.
1020 R. Lavender—Lubricator.
1021 P. Passavant—Colouring matters.
1022 J. Cornes and C. Davis—Lawn mowing machines.
1023 J. Thompson—Barrels for fire-arms.
1024 J. Thompson—Punching metals.
1025 W. A. Shaw—Lining lead pipe with tin.
1026 J. Hinks and J. Newman—Buttons.
1027 J. H. Johnson—Treating oils.

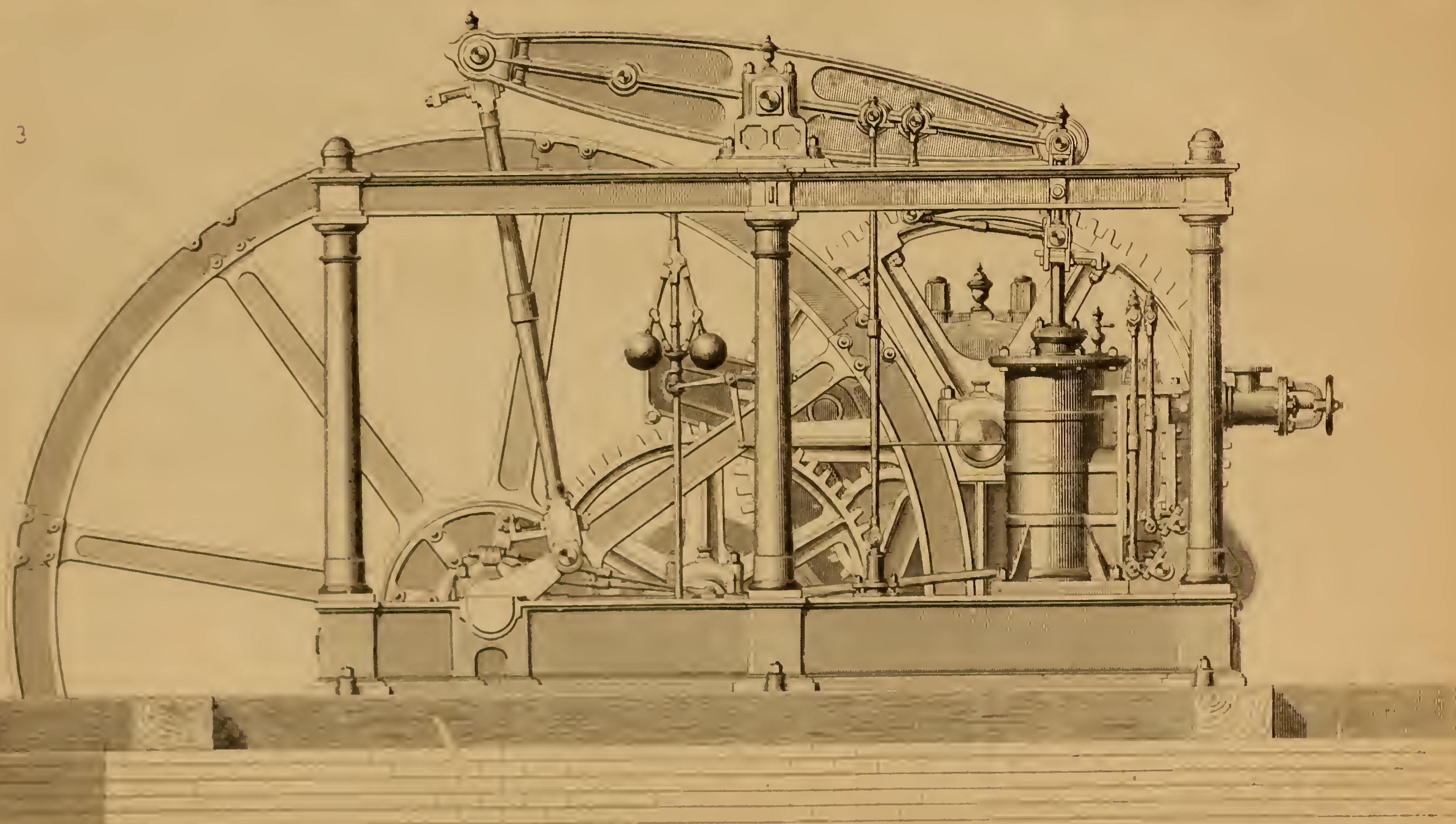
Dated April 25th, 1863.

1028 C. Pooley—Preparing and spinning cotton.
1029 L. de Breanski—Fixing drills.
1030 S. Harrison—Type.
1031 A. H. Clark and H. Hope—Valves.
1032 T. A. Weston and C. Vivian—Pulleys.
1033 J. P. and E. B. Nunn—Cultivators.
1034 J. Dunbar and J. N. Woodford—Steering ships.

STEAM ENGINE AND SUGAR MILL,

CONSTRUCTED BY MESSRS W & A McONIE, *ENGINEERS*,

FIG 3



STEAM ENGINE AND SUGAR MILL,

CONSTRUCTED BY MESSRS W & A McONIE, *ENGINEERS,*

GLASGOW.

FIG. 1.

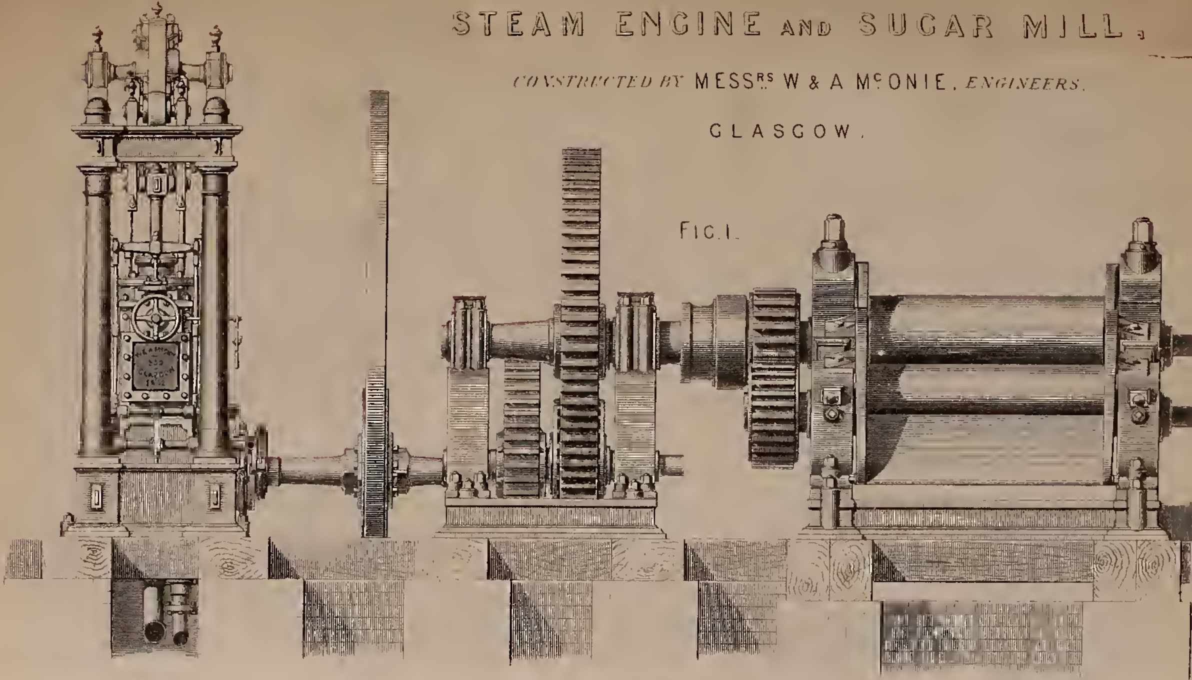


FIG. 2.

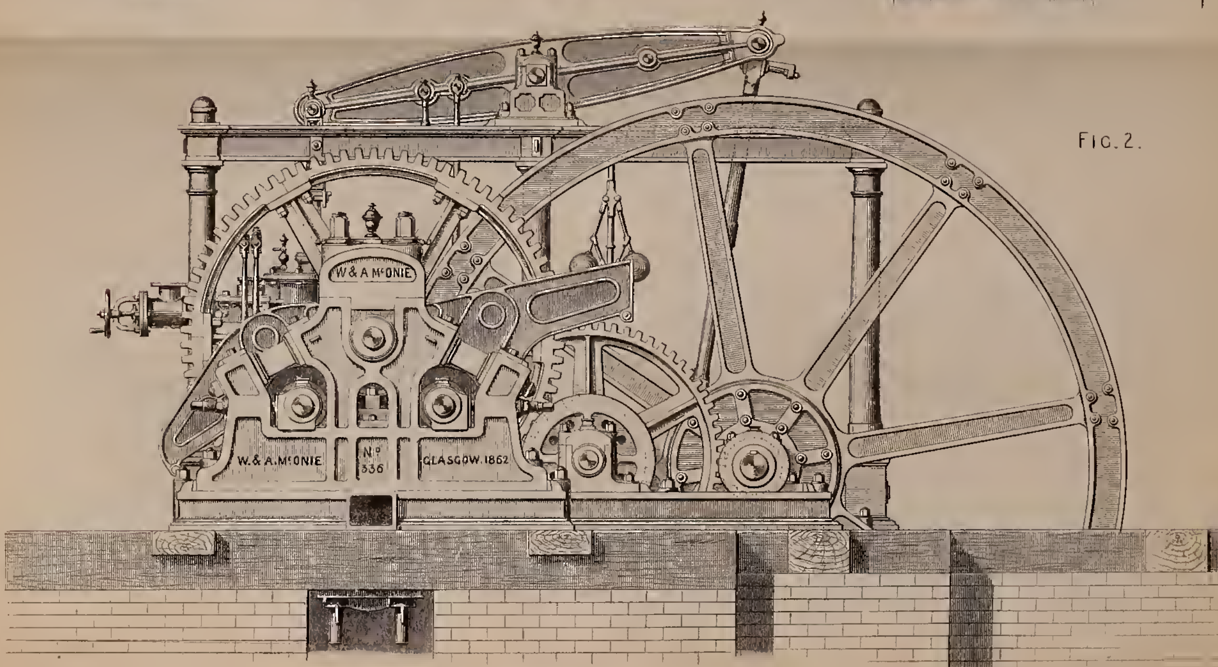
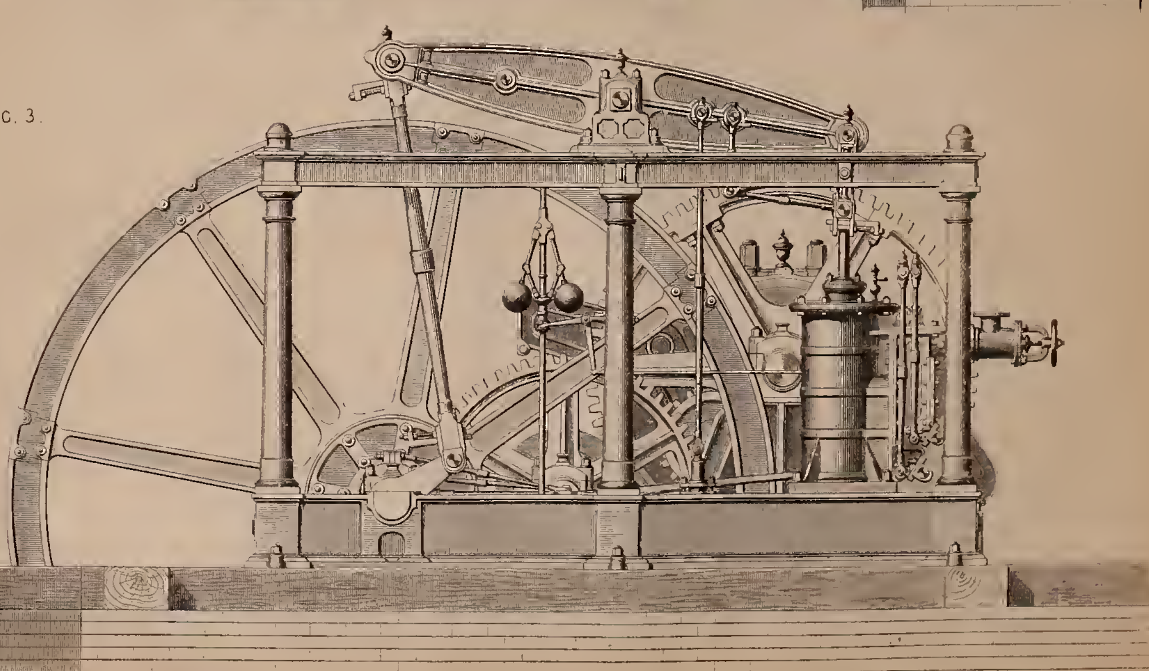


FIG. 3.



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LOCOMOTIVE ENGINEERING.

FIG: 1.

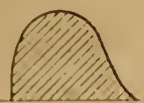


FIG. 2.

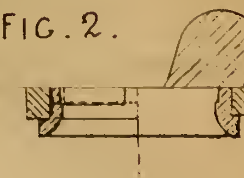


FIG: 16.

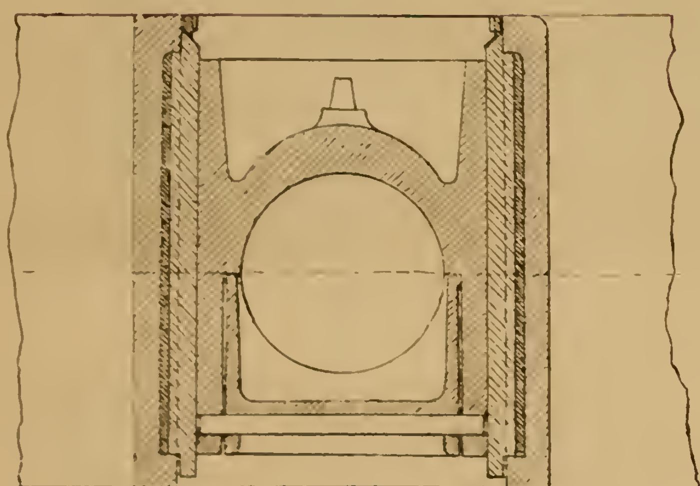


FIG: 19.

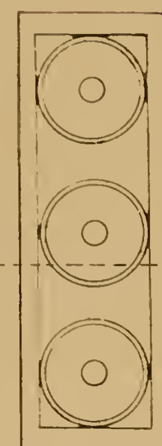


FIG: 18.

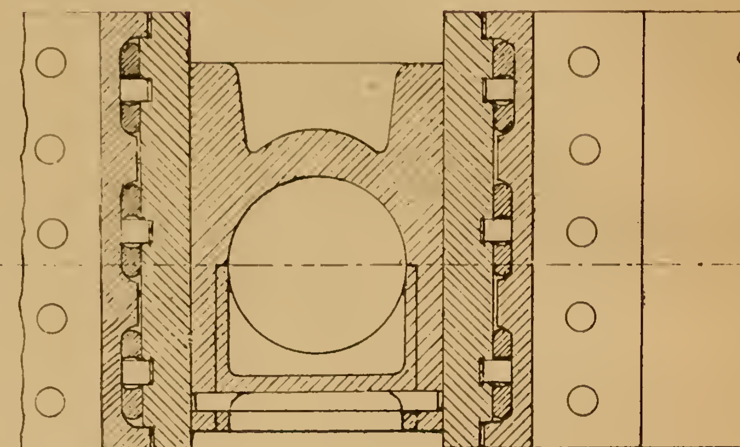


FIG: 17.

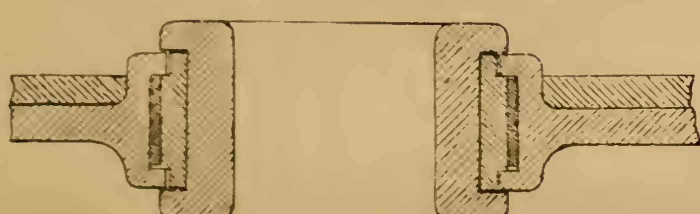


FIG: 20.

W. Smith. C.E. direx.

LOCOMOTIVE ENGINEERING.

WHEEL TYRES & AXLE BOXES.

FIG: 1.

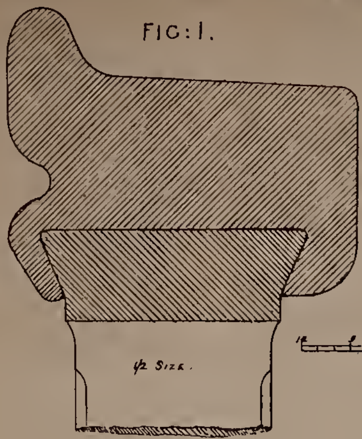
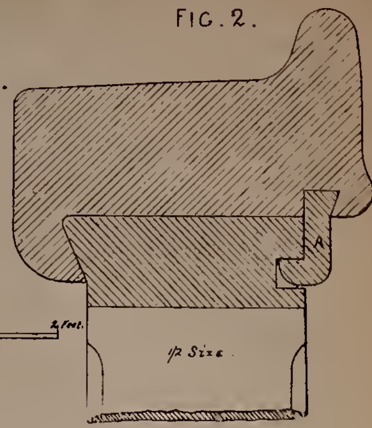


FIG. 2.



SCALE FOR FIGS 3 TO 20.

FIG: 3.

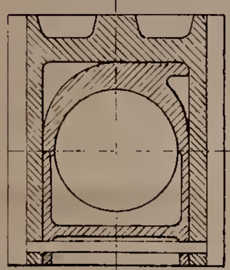


FIG: 4.

FIG: 5.

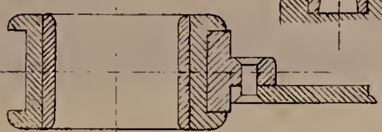


FIG: 6.

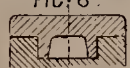


FIG: 7.

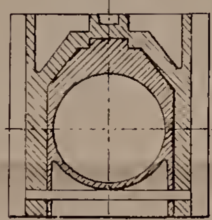


FIG: 8.

FIG: 9.

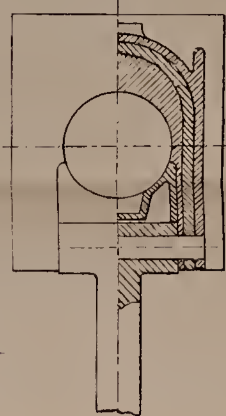


FIG: 10.

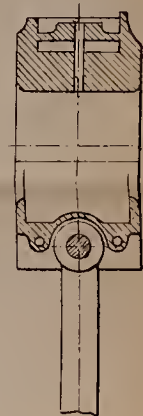


FIG: 11.

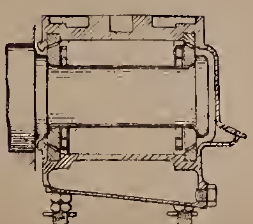


FIG: 12.

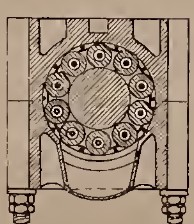


FIG: 13.

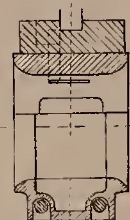


FIG: 14.

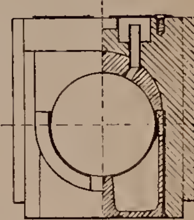


FIG: 15.

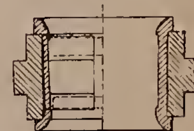


FIG: 16.

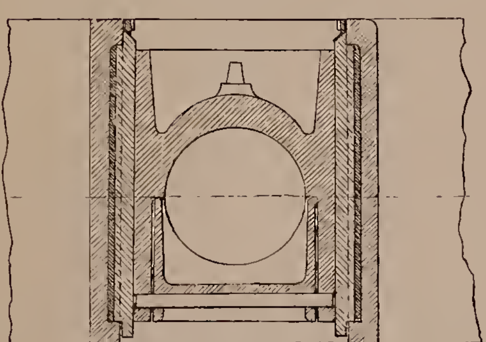


FIG: 19.

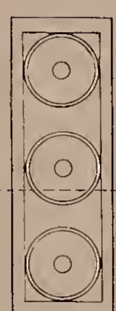


FIG: 18.

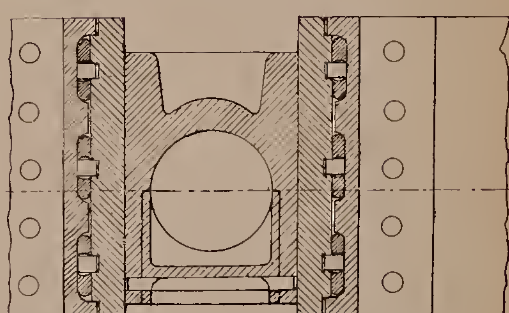


FIG: 17.

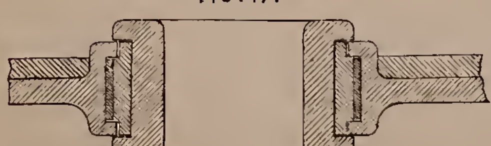


FIG: 20.

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THE ARTIZAN.

No. 6.—Vol. 1.—Third Series.

JUNE 1st, 1863.

STEAM ENGINE AND SUGAR MILL.

Constructed by Messrs. M'Onie Bros., Engineers, Glasgow.

(*Illustrated by Plate* 212.)

Plate 212, accompanying the present number, illustrates the larger of the two sugar mills, with the engine for driving it, exhibited at the late International Exhibition, by Messrs. M'Onie Bros., of Glasgow, who have acquired a well-earned reputation for the production of this class of machinery. In our Plate, Fig. 1 is a front elevational view of the steam engine and sugar mill; Fig. 2, a side elevation of the same; and Fig. 3, an end elevation thereof.

We have already had occasion to allude to Messrs. M'Onie's sugar machinery in our series of Artizan Exhibition Supplements; and in No. 3 of that series, we illustrated a portion of the machinery exhibited by that firm.

The sugar mill illustrated by the accompanying Plate is worked by a high pressure steam engine of 30 nominal horse power, fitted with the usual short slide valve, and an expansion valve arranged to cut off the steam at any part of the stroke. The diameter of steam cylinder is 21in., and the stroke 3ft. 6in. The fly-wheel is 18ft. diameter, and the main shaft and other motive parts are all of forged iron. The engine is regulated to run at 35 strokes per minute, and with high pressure, steam is capable of being worked up to 60, to 80 indicated H.P.

The connection of the engine power to drive the cane mill is carried through a set of double gear spur wheels, which with their shafts and gearing standards, are all securely arranged inside, and fixed to, a strong bed casting. The speed of the steam engine and gearing is arranged so that the surface of the periphery of the cane mill rollers moves about 19ft. per minute.

The sugar cane mill is of the usual three-rollered form—rollers, 5½ft. long by 28in. diameter. The mill bed forms the receiver for the juice; and the side framings for carrying the rollers are so constructed that any of the rollers can be removed, if occasion occurs for such, without dismantling the framework.

The steam engine with its sugar mill is of a size frequently sent out to the sugar estates, and is capable of grinding canes for making 10 to 12 tons of sugar daily. The weight of the machinery (exclusive of boiler) is about 75 tons.

The smaller, or cattle power sugar mill previously alluded to, was, in general arrangement, similar to the larger mill, but having the necessary attachments for the bullocks or mules.

We may add that the machinery—the subject of our plate—was, at the close of the Exhibition, forwarded direct from London to Trinidad, to the Brechin Castle estate of Messrs. Gregor, Turnbull and Co., of Glasgow.

A CRITICAL AND HISTORICAL REVIEW OF LOCOMOTIVE ENGINEERING.

By J. J. Birckel.

(*Illustrated by Plate* 213.)

(*Continued from page* 102.)

Closely connected with the general question of stability of the engine is that of the state of repair of the carriage proper and especially that of the wheel tyres, the axle bearings, and the axle-boxes. One great cause of instability of the engine is the want of parallelism of the axles, the tendency of which is to divert the engine from its straight course and to produce, or to assist in producing, that sinuous motion, already spoken of when treating of the disturbing element of the parts of machinery in motion. The parallelism is especially affected by the play of the axles in their bearings and of the axle boxes in the frame cheeks, or horn plates, the structure and construction of all which should, therefore, be such as to offer the least possible liability to wear. The realization of this object has been aimed at both in the axle bearings and in the frame cheeks, by providing as large a frictional surface as possible, and in journals by increasing their length when the condition of strength and durability of the axle as affected by its diametre is satisfied; in driving axles the diameter of inside bearings varies from 5 to 7½in., according to the size of the engine, these being very likely the extreme limits in locomotives for ordinary traffic; the length of the journal, which 15 years ago probably never amounted to 7in. in any of the engines upon the narrow guage, now very frequently reaches the somewhat large dimension of 10in., and is seldom less than 7in. When the axle has both inside and outside bearings, these are generally smaller in diameter but at the same time longer, though without any definite ratio to the inside ones. Mr. Clark, it is true, adduces very plausible reasons to show that the frictional area of the inner ones should be considerably larger than that of the outer ones, yet in practice the opposite more generally occurs, for the very simple reason that when room is provided for a capacious inside bearing, the engineer prefers to dispense with the outside one altogether. In coupled engines the dimensions of the journals of the leading and trailing axles are generally equal to those of the driving axle, for the sake of simplicity; in uncoupled engines their diameter varies from 4 to 5½in., it being generally larger in inside bearings than in outside ones, and the range in length remains as previously stated. We shall have occasion to refer again to inside and outside bearings, when treating of the general principles of construction of the engine frame.

Driving axles which used to be made almost invariably of Yorkshire iron, are now very frequently, and upon some railways exclusively, made of Krupp's, or Bessemer's steel. Mr. Ramsbottom, who makes them, we believe, of Bessemer's steel, does not, on that account, reduce their diameter, but Mr. Sinclair who makes them of Krupp's steel, reduces it by the full amount of one-sixth, at least, of its original diameter, and thus realizes an apparent saving equal to about $\frac{1}{350}$th of the total cost of the engine.

Axle-boxes used to be made exclusively of cast-iron with brass steps fitted into them, as illustrated by Figs. 3 to 8, plate 213. At a later date the driving axle-boxes were frequently made of wrought-iron, as illustrated by Figs. 13, 14, and 15 in the same plate, chiefly with a view to avoid breakages; and on the Continent they are now invariably made of that material; with English engineers, however, it becomes now a general practice to make them wholly of brass, with a wrought-iron strap cast into them, as illustrated by Figs. 9 and 10. This strap is a great safeguard to the sides of the box against the sudden shocks to which they are subjected, and are almost indispensible with underhung springs, when they are expected to carry the whole load upon that journal. Mr. Ramsbottom lines them with Babitt's metal, as most of the other journals and wearing surfaces, and from its use he derives unquestionable benefits. As remarkable instances of the property of this alloy to keep the journals cool during long and rapid journeys, we may instance a journey of the engine "Lady of the Lake," which has been recorded in The Artizan, which conveyed the Irish mail over a distance of 113 miles in 144 minutes without stopping; it may also be stated that another engine of the same class took the same train over a distance of 264 miles without changing.

Breakages across the thinner parts of the sides of the axle-boxes occur very frequently from shocks when there is any play in the journals, or between the sides of the box and the horn plates, and, in order to prevent these, and at the same time to soften the reciprocations of the parts of machinery in motion, Mr. Haslam, of Messrs. Fairbairn and Sons, patented the axle-box, illustrated by Figs. 16 to 19, where an india-rubber lining is interposed between the hard surfaces of the box and the horn plates, that lining acting as a spring; in order to protect the india-rubber against oil, and other causes of deterioration, the horn plates are recessed and the india-rubber compressed into the recess, a wrought-iron plate being placed between it and the axle-box; in leading axle-boxes this plate is wedge shaped, and the box has ¼in. of play on each side of the horn block to enable the axle to adjust itself to the requirements of the road when passing over curves. In a paper read before the Society of Mechanical Engineers, in 1858, it was stated that some axle-boxes fitted up in this manner, which had run as many as 17,000 miles, were still as perfect as when new, and that the definite result ascertained was a diminished wear of the wheel flanges where, in the case of leading wheels the elastic axle-boxes had been used; it was also generally admitted at the meeting that

the interposition of the india-rubber was a decided improvement. Another attempt at improving the construction of axle-boxes with a view to avoiding rapid wear is the one illustrated by Figs. 11 and 12, lately applied by Mr. Sinclair to some tenders for express engines, we believe by way of experiment; here the journal rests upon a series of brass rollers, disposed around the circumference of the journal, and when the carriage is set in motion, it is expected that these rollers will revolve upon their own centres, and that the loss of power and wear of the working faces will be that only due to rolling friction; the centres of the rollers are made of steel, and rest in steel rings, though in reality they have not to carry any pressure, since that is transmitted from the axle-box to the journal, through the body of the rollers directly; we understand, however, that these boxes have already been replaced by common ones.

Horn plates are generally made of cast-iron, rivetted or bolted to the body of the frame, and are made as broad as circumstances will permit, in order to get as large a wearing surface as possible; longitudinally they should form a good fit with the axle-boxes, but sideways there should be a little play, in order to enable the wheels to adjust themselves more easily to the inequalities of the road. Mr. M'Connell, in his later practice, used to forge the horn plates solid with the frame, and thus made a very good and substantial job for strength and durability, although at the same time it was very expensive. Mr. Ramsbottom makes them of Bessemer's cast steel, in the shape of a horse shoe, fitting round the whole of the frame fork; this in the present condition of the manufacture of steel is cheaper than the method previously mentioned, and is probably more durable.

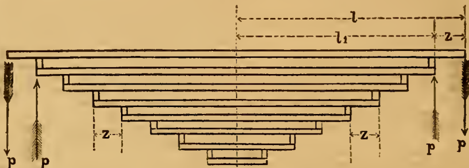


Fig. 9.

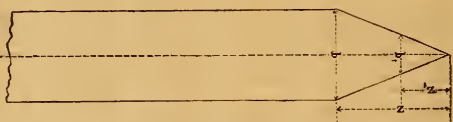


Fig. 10.

Fig. 11.

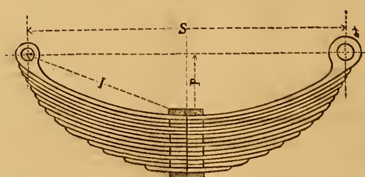


Fig. 12.

Wheels for locomotives and tenders have for many years been made of wrought-iron, both in this country and abroad, on account of their great elasticity, which is conducive alike to the preservation of the parts of the engine, and of the permanent way; the spokes are from 10½in. to 12in. distant at the rim of the wheel; their thickness varies from 1¼in. to 1½in. and their width from 3½in, to 4½in. Wheel tyres used to be made invariably of Yorkshire iron, shrunk on the wheel and fixed in addition by means of a few rivets, with a view chiefly to prevent the tyre coming loose when worn down so thin, as to roll itself out during performance of its work. Now, however, they are made very frequently of Krupp's steel, which is less liable to wear, and causes the tyres to preserve their original shape during a greater period of time.

It occasionally happens, and especially so in steel tyres, that they break when in use, and that a piece flies off, impelled by the centrifugal force generated by the rotary motion of the wheel; this circumstance has been the cause of serious accidents, and in order to prevent them, some engineers have thought it advisable to fasten the tyres in such manner as effectually to prevent portions of them flying off in the manner stated. Figs. 1 and 2, show two different contrivances to effect this; the one by Beattie with clips placed between each pair of spokes, and a continuous dovetail on the outside of the wheel; the other by Burke, in which the tyre is dovetailed all round both inside and outside; this latter is in our opinion, the most extravagant piece of work that has ever been proposed from the earliest days of locomotive engineering to the present time.

We have already had occasion to make mention of the springs in the course of our introductory remarks on the stability of the engine, and as the analysis of the duties to be performed by them forms an integral part of the general problem of stability, we shall here proceed upon that analysis and, incidentally, give an exposition of the theory upon which their construction should rest, and endeavour at the same time to lay down practical rules to define their proportions.

The beneficial results of the interposition of springs between the load and the axle, or the wheels in all vehicles of what kind soever, are so universally appreciated that it is scarcely necessary to make mention of them. They tend both to the preservation of the road and of the vehicle itself, while as regards the freight, they render land carriage far more agreeable to man, and make it less hazardous, or injurious, to many descriptions of perishable or fragile goods. A fact much less apparent is the one ascertained by General Morin, that the interposition of springs considerably diminishes the resistance to traction. Thus we find it stated in the record of his valuable experiments on traction upon common roads, that at a speed of nine miles per hour, suitable springs diminish the resistance by one half; and we find also that experiments made upon two waggons exactly similar in all other respects, the one being with and the other without springs, showed that the wear of the road, as well as the increase of resistance to traction, was sensibly the same after the passage of 4577 tons over *the same track*, for the carriage without springs going at a pace of from 2·237 to 2·686 miles per hour, and for that with springs going at a trot of from 7·158 to 8·053 miles per hour. If the reader here does call to mind the facts elucidated in our paper on train resistances, where it was shown that these latter increase in a certain ratio with the speed, he will not fail to appreciate the importance of the interposition, and of the proper arrangement and construction of the springs, in their relation to the economy of railway engineering in general, and of locomotive engineering in particular.

As affecting the stability of the engine in progress upon the road, the leading springs should be sufficiently stiff to absorb rapidly the rolling motion caused by the component upward pressure of the steam; compared with the other springs they are subject to the greatest fatigue, because upon them must be wasted all the irregularities of motion arising from the labour of leading the engine, in the performance of which labour there should be the least possible pendulous motion to the front, in order to save the frames from being twisted, and to keep the axle bearings true. Their flexibility is not to exceed $\frac{1}{16}$th of an inch per ton load, unless the wheels are well forward, in which case this limit may be slightly exceeded. In uncoupled engines the driving springs should have great elasticity, or in other words, a great range of deflection, to enable the wheels to follow the rails freely, and to maintain the tractive load as equal as possible; for the same reasons also should the trailing springs be very flexible to

give way to the driving springs, while the great elasticity in them is also a boon to the engine driver. Driving and trailing springs in uncoupled engines have an elasticity of from $\frac{1}{2}$in. to $\frac{5}{8}$in. per ton. In six wheel coupled engines, drawing heavy loads and running at low speeds, the elasticity of the springs is limited to about $\frac{5}{16}$ of an inch per ton load, and in engines having all the wheels under the boiler, the trailing springs have an elasticity of $\frac{1}{4}$ of an inch only to avoid as much as possible the pitching motion spoked of at the beginning of this part of the subject. Mr. Clark, upon entering into the question of constuction of springs, says that "the whole subject is in the hands of empiricists, who work by thumb and by rote," and in this we are inclined to agree with him, though we are constrained to limit that assertion to *some* engineers only. As for Mr. Clark himself, he no doubt has some correct ideas about the laws of deflection and strength of springs, but when he says that "the outer contour of the spring should be as nearly as practicable a parabolic outline when the spring is flat, in order to secure uniformity of strength," he evidently is working by rote also, and had he looked more closely into the subject, or consulted the writings of such as are known to discard empiricism, he would have know that the law laid down by himself, as to the outer contour, is totally erroneous; there are, indeed, many locomotive engineers who labour under that delusion, but we know also that there others, among whom we may mention Mr. Ramsbottom, who construct their springs more in accordance with the theory which we are now about to develope, the correctness of which, we think, cannot be impeached. Let the adjoining sketch (Fig. 9) represent a series of plates resting upon one another by means of narrow distance plates resting upon one another by means of distance blocks; the plates are all of the same thickness and of the same width throughout, but they vary in length in such manner. If the difference be a constant quantity, and if n be the number of plates, we shall have $n\,z = l$; if certain pressures p be applied to the ends of the upper plates they will transmit themselves unchanged to all succeding plates, each of which will be subjected to two couples placed symmetrically on each side of the axis A. B., and the condition of equilibrium is expressed by the general equation.

$$\frac{E\,b\,t^3}{12\,\rho} = p\,(l - x) - p\,(l_1 - x) = p\,z \quad \text{.............} \quad (1)$$

in which equation E represents the modulus of elasticity of the plates, b their breadth, t their thickness, ρ the radius of curvature of the element of the plate under consideration, and x the distance of that element from the axis A, B subject to the condition that x be smaller than l_1; from equation (1) we readily deduce the following:—

$$\frac{E\,b\,t^3}{12\,p\,z} = \rho \quad \text{..} \quad (2)$$

and owing to the condition that p and z are constant, these two equations teach us, first, that the molecular stress, or, as it is termed, the moment of elasticity, is constant throughout the length of the plates; secondly, that, within the same limits, the radius of curvature is constant, or, in other words, that the plates bend according to an arc of circumference. If, however, in equation (1) x be made larger than l_1, then the general equation of equilibrium reads thus—

$$\frac{E\,b\,t^3}{12\,\rho} = p\,(l - x) \quad \text{...} \quad (3)$$

and indicates that the radius of curvature decreases in proportion as the point x shifts from the point of support towards the end of the plate; the condition of preserving the radius of curvature unchanged, however, may be realised in two ways—first, by giving the projecting portion of the plate a triangular shape as per sketch (Fig. 10) in such manner as to have always

$$b_1 = \frac{b\,Z_1}{Z}$$

or by reducing its thickness, as per sketch (Fig, 11), in such manner as to have always

$$t^3_1 = t^3\,\frac{Z_1}{Z}$$

for in the first instance equation (3) becomes

$$p\,z_1 = \frac{E\,\frac{b\,Z_1}{Z}\,t^3}{12\,\rho}$$

whence

$$\rho = \frac{E\,b\,t^3}{12\,p\,Z}$$

and in the second case it becomes

$$p\,z_1 = \frac{E\,b\,\frac{t^3\,Z_1}{Z}}{12\,\rho}$$

whence again

$$\rho = \frac{E\,b\,t^3}{12\,p\,Z}$$

for any value of Z_1, and at the same time the condition of equal strength is exactly realised in the first case, and in the second case the plate is slightly stronger than a solid of equal resistance.

Let us now apply these considerations to an ordinary curved spring whose plates are bent to an arc of circumference, as per adjoining cut (Fig. 12), where l is nearly equal to the half length of the plate, and

$$l^2 = 2\,S\,d \text{ or } d = \frac{l^2}{2\,\rho} \quad \text{.......................................} \quad (4)$$

ρ being the radius of curvature; but according to what has been said

$$\rho = \frac{E\,b\,t^3}{12\,p\,Z}$$

and if we substitute this value of ρ in equation (4), we find for d the following value—

$$d = \frac{l^2\,6\,p\,Z}{E\,b\,t^3}$$

and if at the same time we remember that $l = n$ Z, we obtain finally

$$d = \frac{6\,p\,l^3}{n\,E\,b\,t^3} \quad \text{...} \quad (5)$$

From this equation we may calculate the deflection under a given load p, but it is not sufficient to enable us to construct the spring, for we do not yet know what thickness and what number of plates are required to enable it to carry that load with safety; this will be realised if it is constructed in such manner as to satisfy to the condition expressed in the following equation:—

$$p\,Z = \frac{R\,b\,t^2}{6}$$

where R stands for the strain per square inch, with which the metal may safely be loaded; but as we have also the relation

$$Z = \frac{l}{n}$$

we obtain finally for the condition of safety

$$p = \frac{R\,n\,b\,t^2}{6\,l} \quad \text{...} \quad (6)$$

and if this value of p be introduced into equation (5), we shall define the maximum deflection which the spring may take with safety, as follows:—

$$D = \frac{R\,l^2}{E\,t} \quad \text{...} \quad (7)$$

So far we have dealt with one half of the spring only, but for practical purposes it will be more convenient to introduce the total load and span into the above formulæ, which, if S be the span, w any assumed load not exceeding the limit of elasticity, and W the whole working load which the spring shall carry, will be modified, as follows:—

For deflection under given load,

$$d = \tfrac{3}{8}\,\frac{w\,S^3}{n\,E\,b\,t^3} \quad \text{...} \quad (8)$$

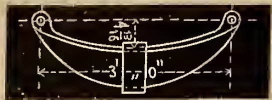
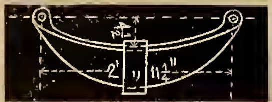
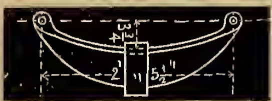
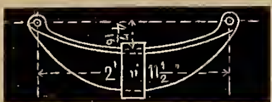
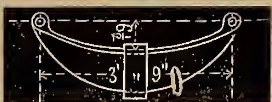
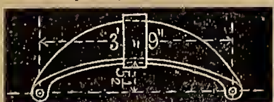
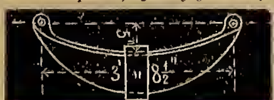
For the safe working load,

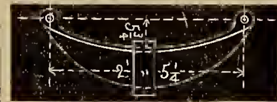
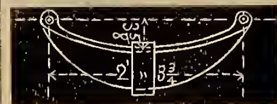
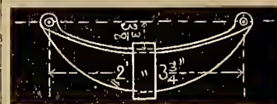
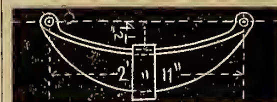
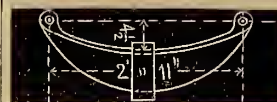
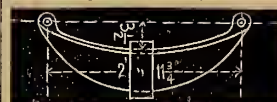
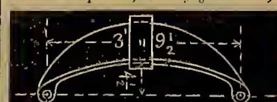
$$W = \tfrac{2}{3}\,\frac{n\,R\,b\,t^2}{S} \quad \text{...} \quad (9)$$

And for maximum deflection consistent with safety,

$$D = \tfrac{1}{4}\,\frac{R\,.\,S^2}{E\,t} \quad \text{...} \quad (10)$$

which formulæ will enable the student to construct springs for any given load and circumstances, provided we supply him with the numerical values of E and R. These values as accepted for the general purposes of engi-

Description of spring.	Deflections in inches for loads in cwts.							Value of R in tons per sq. inch.	Value of E in tons per sq. inch.
	45	50	70	90	110	130	150		
	ins.	ins.	ins.	ins.	ins.	ins.	ins.	tons.	tons.
 Working load, 6 tons 5 cwt. 21 plates, $4\frac{1}{2}$in. by $\frac{3}{8}$in.	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{13}{16}$	$1\frac{1}{8}$	$1\frac{3}{8}$	$1\frac{11}{16}$	$1\frac{15}{16}$	25·5	11287
 Working load, 4 tons 15 cwt. 16 plates, $4\frac{1}{2}$in. by $\frac{3}{8}$in.	$\frac{1}{2}$	$\frac{5}{8}$	1	$1\frac{1}{4}$	$1\frac{5}{8}$	2	...	25	13890
 Working load, 2 tons 16 cwt. 12 plates, 4in. by $\frac{3}{8}$in.	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{3}{4}$	...	...	...	...	18·4	12189
 Working load, 5 tons 8 cwt. 21 plates, 3in. by $\frac{3}{8}$in.	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{7}{8}$	full $1\frac{3}{16}$	bare $1\frac{9}{16}$	full $1\frac{13}{16}$	...	32·6	16210
 Working load, 5 tons. 20 plates, $3\frac{1}{2}$in. by $\frac{3}{8}$in.	$1\frac{1}{8}$	$1\frac{3}{8}$	$2\frac{1}{8}$	$2\frac{7}{8}$	bare $3\frac{5}{8}$	bare $4\frac{3}{8}$	$5\frac{1}{8}$	34·4	12366
 Working load, 4 tons. 20 plates, $3\frac{1}{2}$in. by $\frac{3}{8}$in.	$1\frac{1}{8}$	$1\frac{5}{16}$	2	$2\frac{11}{16}$	bare $3\frac{3}{8}$	4	...	27.5	13668
 Working load, 5 tons 2 cwt. 19 plates, $3\frac{1}{2}$in. by $\frac{3}{8}$in.	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{9}{16}$	bare $\frac{3}{4}$	$\frac{15}{16}$	$1\frac{1}{8}$	...	24·2	13753
 Working load, 3 tons 16 cwt. 12 plates, 4in. by $\frac{5}{8}$in.	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{9}{16}$	full $\frac{3}{4}$	1	$1\frac{1}{4}$	...	13·8	15020

Description of spring.	Deflections in inches for loads in cwts.							Value of R in tons per sq. inch.	Value of E in tons per sq. inch.
	45	50	70	90	110	130	150		
	ins.	ins.	ins.	ins.	ins.	ins.	ins.	tons.	tons.
 Working load, 4 tons 18 cwt. 16 plates, 4in. by $\frac{3}{8}$in.	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{11}{16}$	full $\frac{7}{8}$	full $1\frac{1}{8}$	$1\frac{3}{8}$	...	24	11410
 Working load, 2 tons 10 cwt. 11 plates, $2\frac{3}{4}$in. by $\frac{3}{8}$in.	$\frac{3}{4}$	$\frac{7}{8}$	$1\frac{3}{8}$	...	...	...	...	29·6	23497
 Working load, 6 tons 5 cwt. 21 plates, $3\frac{1}{4}$in. by $\frac{3}{8}$in.	$\frac{3}{16}$	$\frac{1}{4}$	full $\frac{7}{16}$	full $\frac{9}{16}$	bare $\frac{13}{16}$	$\frac{15}{16}$	$1\frac{1}{8}$	27·3	13728
 Working load, 4 tons 14 cwt. 16 plates, 4in. by $\frac{3}{8}$in.	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{11}{16}$	$\frac{7}{8}$	$1\frac{1}{16}$	...	...	21·8	12194
 Working load, 4 tons 10 cwt. 19 plates, 4in. by $\frac{3}{8}$in.	$\frac{9}{16}$	bare $\frac{11}{16}$	$\frac{15}{16}$	$1\frac{5}{16}$	$1\frac{5}{8}$	2	...	22·1	12992
 Working load, 4 tons. 18 plates, 4in. by $\frac{3}{8}$in.	$\frac{9}{16}$	$\frac{5}{8}$	1	$1\frac{5}{16}$	$1\frac{5}{8}$	2	...	21	12343
 Working load, 2 tons. 10 plates, 4in. by $\frac{3}{8}$in.	1	$1\frac{1}{8}$	$1\frac{11}{16}$	$2\frac{5}{16}$	...	...	...	19·2	14827
 Working load, 6 tons 15 cwt. 19 plates, 6in. by $\frac{1}{2}$in.	$\frac{3}{16}$	$\frac{1}{4}$	bare $\frac{3}{8}$	$\frac{1}{2}$	full $\frac{5}{8}$	$\frac{13}{16}$	1	12	19830

Received value of E from 11,200 to 17,850 tons per square inch.

Mean values of R and E.......... 23·6 14280

neering may be found in various works on practical mechanics, but the reader will at once perceive that these may scarcely be expected to apply to the present case, where the elasticity of the spring as manifested by its deflection may be much affected by the mode of connection and superposition of the plates, and where the peculiar circumstances under which it is called upon to do its work, must have a great influence in the assumption of the unit strain. Here again, therefore, we think we cannot do better than turn to actual practice to supply this want, and on the preceding page we give a table of springs as made by Messrs. Sharp, Stewart, and Co. for various descriptions of engines, with their working load attached to each of them, and an abstract of tests made to ascertain the deflection nnder a gradually increasing weight. The working loads in conjunction with the other particulars of the springs will enable us to find a practical val1e for R, and the deflections with their corresponding loads will enable us to find a practical value for E.

Upon inspection of this table it will be perceived that in each individual case the elasticity of the spring remains constant for equal additions to the load throughout the range of the tests which have been carried to a point far beyond the actual load of the spring. The value of the co-efficient of elasticity, E, as calculated by means of formula (8) for each spring remains within the limits generally assumed for that factor, with the exception only of two cases, in both of which it exceeds the maximum limit, as we indeed at the outset anticipated it should do, owing to the frictional resistance to bending from closeness of connection of the plates; in both cases, however, the construction of the spring is of somewhat exceptional character, yet, notwithstanding these irregularities, for the 16 cases the mean value of E is very nearly an arithmetical mean between the upper and the lower limits of the value assigned to it by Dr Rankine. The value of R, or the unit stress under the working load at rest, is somewhat considerable, ranging from 12 to 34·4 tons, and for the 16 cases, averaging 23·6 tons, and if an arithmetical mean be taken between these and the mean working load divided into it, the factor of safety will be found equal to 2 exactly. As there are no indications, however, that the elasticity of the metal has sustained any injury, though the tests have been carried much beyond the working load, and as the cases recorded in the table above, embody not only the experience of Messrs. Sharp, Stewart, and Co., but also that of various engineers both at home and abroad, the mean value of R, which we have found, may, with confidence, be taken as a sufficient amount of safety for the particular case of locomotive springs here under consideration. If these mean values of E and R be introduced into formulæ (8), (9), and (10), these may be put into the following shape, viz:—

For the deflection under a given load,

$$d = \frac{1}{38080} \cdot \frac{w\,S^3}{n\,b\,t^3} \quad \dots\dots\dots\dots \quad (8a)$$

For the safe working load,

$$W = 16.4\,\frac{n\,b\,t^2}{S} \quad \dots\dots\dots\dots \quad (9a)$$

And for the maximum safe deflection,

$$D = \frac{1}{2420} \cdot \frac{S^2}{t} \quad \dots\dots\dots\dots \quad (10a)$$

where w and W are expsessed in tons, and S, h, t, d, and D, in inches and fractions of inches.

To facilitate comparison with Mr. Clark's formulæ, which we have transcribed below, we have modified the notations in the preceding formulæ, giving. like Mr. Clark, the deflection d, and the thickness t, in sixteenths of inches, S and b remaining as before:—

$$d_1 = 1{\cdot}72\,\frac{w\,S^3}{n\,b\,t_1^3} \quad \dots\dots\dots\dots \quad (8b)$$

$$W = \frac{1}{15{\cdot}6} \cdot \frac{n\,b\,t_1^2}{S} \quad \dots\dots\dots\dots \quad (9b)$$

$$d_1 = 1{\cdot}66\,\frac{w\,S^3}{n\,b\,t_1^3} \quad \dots\dots\dots\dots \quad \text{(Clark)}$$

$$W = \frac{1}{11{\cdot}3} \cdot \frac{n\,b\,t_1^2}{S} \quad \dots\dots\dots\dots \quad \text{(Clark)}$$

The great analogy between these formulæ shows that we were quite justified in saying that Mr. Clark had some correct ideas about springs, and though his numerical co-efficients have been obtained by a process widely different from our own, yet must they have been nearly identical with those found by ourselves, had he based his calculations upon a number of different examples instead of one only.

From a careful study of the theoretical considerations which form the earlier portion of this part of our subject, the reader will perceive also that the contour of the spring has nothing in common with the parabola, but that, in order to realise the condition of practically perfect elasticity and equal strength, the contour of the spring when it is under its maximum deflection, should be as near as possible such, that the projection of each plate over the one immediately underneath it be equal througbout the length of the spring. This condition is decidedly aimed at in Mr. Ramsbottom's springs.

Springs which are intended to have much elasticity should be with considerable camber, so that they may expand as they receive their load, and the increased stiffness from friction of the plates be compensated by the increase of span. Upon looking over the preceding table it will be found that the springs which have the greatest elasticity have an original camber of from one-seventh to one-tenth the span. The plates of springs are held together by means of a buckle shrunk on in the centre, and at the ends they have generally studs punched on them, which are made to fit into corresponding slots in the contiguous plate; this, however, is unquestionably a source of weakness to the spring, and we believe Mr. Ramsbottom has dispensed with the slots altogether, and simply stamps nips upon the ends of the plates in such manner as to cause them to fit into each other. This is, we consider, decidedly the more preferable plan.

(To be continued.)

THE RUSSIAN IRON-CASED BATTERY "PERVENETZ."

We have given in another column an account of the launch of the iron-cased battery *Pervenetz*, built by the Thames Ironworks and Shipbuilding Company for the Russian Government, together with some other particulars as to the dimensions and characteristic features of that vessel. For the further information of our readers, we insert the accompanying illustrations (given in the next page) and additional remarks:—

Fig. 1 is a longitudinal outline elevational view showing the rig of the vessel general contour of the hull.

Fig. 2 is a half midship section to an enlarged scale.

Fig. 3 is a horizontal section of a portion of the hull amidships, shewing two of the port-holes, the distance between the centre of which is 12ft. 8in.

The height of the bottom of port-hole from the water-line is 7ft.

The height between the top of the lower deck to underside of main deck is 6ft. 10in.

The keel of the *Pervenetz* was laid in April, 1862. The dimensions, &c., having been previously determined upon between the Thames Ironworks Company and the Russian Government, the Company proposed designs which were submitted to, and approved by the Russian Government.

The *Pervenetz* is intended for shallow-water operations in the Baltic, and the peculiarity of her construction renders her specially adapted for this purpose. Her armour plating is 4½in. thick amidships, and 3in. at the ends. The total weight of armour is about 600 tons; the teak backing behind the armour is 10in. thick, worked horizontally. It will be seen, on reference to Fig. 1, that the two ends are of very peculiar shape, which occasioned some considerable difficulty in adapting the armour plating to these parts. The stem is about 3ft. 6in. broad at the water-line, and gradually assumes the form of the flat keel plates at the heel. To the stem is attached the bulkhead running longitudinally as far aft as the foremost engine-room bulkhead, the object of this bulkhead being to give to the stem the necessary strength to withstand concussion in the event of the prow being used as a ram; which, however, is not very likely to be the case, as the vessel is not supposed to steam more than 8 or 9 knots an hour. The stern frame from its peculiarity and novelty is also deserving of notice, and considerable ingenuity has been exercised in the method arrived at by Mr. Macrow,—the naval constructor of the Thames Iron Works and Shipbuilding Company,—of applying the steering apparatus, as the rudder frame being at the extremity of the ship, there is not breadth at that part to give more than about 25 degrees of angle; and in consequence of the foremost post running up to reach the upper part of saddle, there was not sufficient length of tiller. This necessitated the transferring of the centre of the rudder-head to another centre before the foremost post, by means of two strong wheels and an endless chain, so as to get an angle of 42 or more if required. This arrangement will be better understood upon reference to the accompany sketches, Figs 4 and 5; a being the rudder, b and b^1 the two wheels, c the tiller, c^1 the endless chain, d the central line of the propeller shaft, e is the Iron deck at water-line, f is the main deck, g the 3in. armour plating, and h the teak backing.

It was originally intended that the engines of the *Pervenetz* should be of 400 nominal horse-power, but it was afterwards decided that 300 would be sufficient, and would effect a saving of some few inches in the draught. We may add that the Russian Government are themselves building in Russia a similar vessel to the *Pervenetz*..

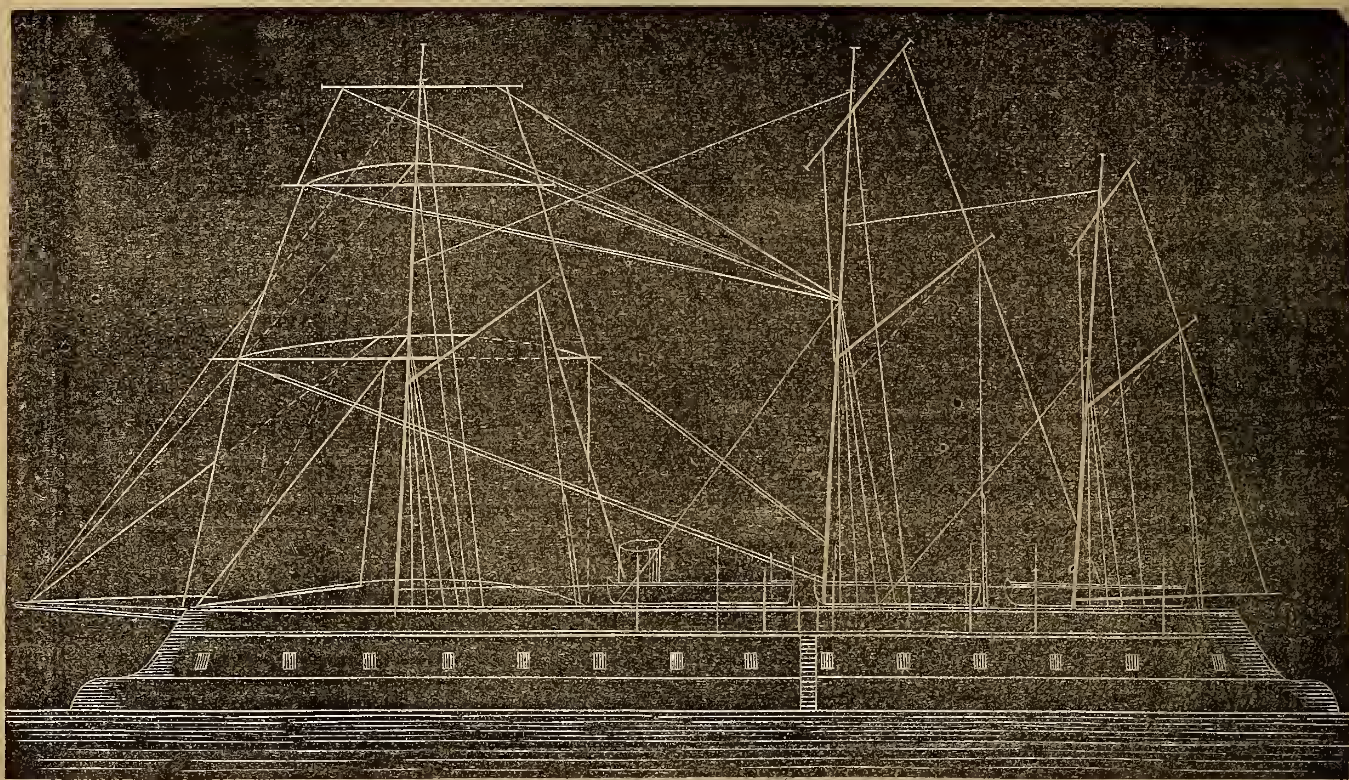


Fig. 1.

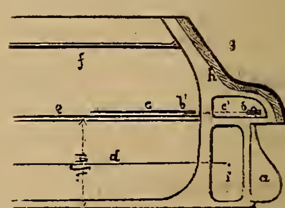


Fig. 4.

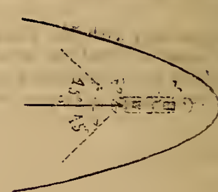


Fig. 5.

Fig. 3.

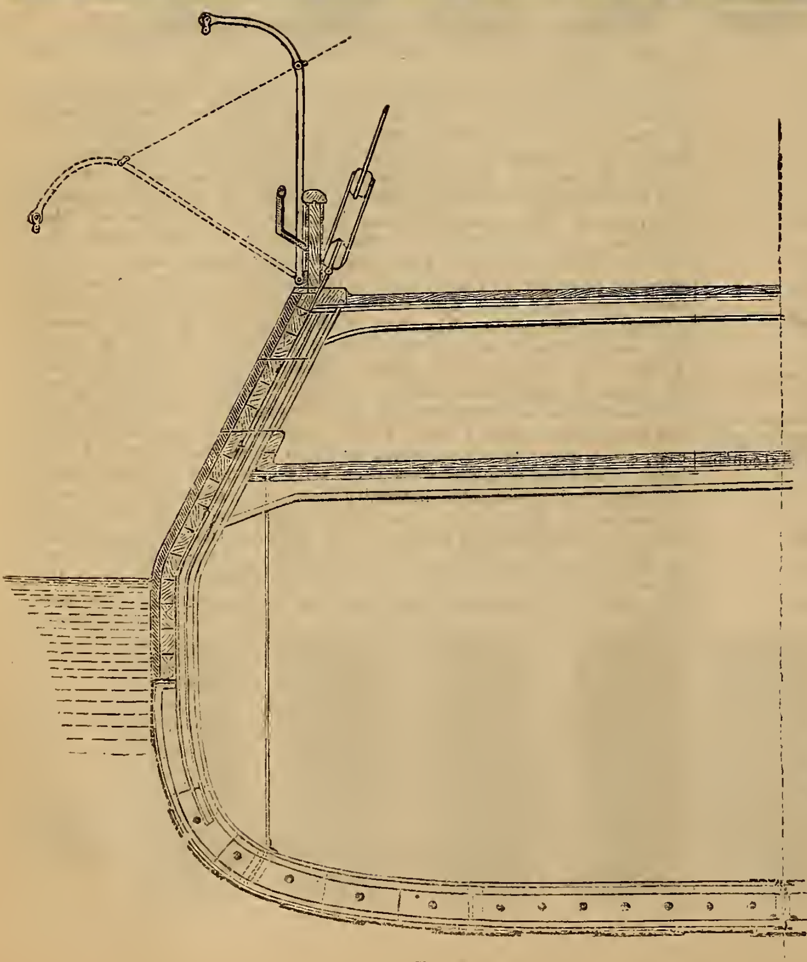


Fig. 2.

INSTITUTION OF MECHANICAL ENGINEERS.

ON THE CONSTRUCTION AND APPLICATION OF IRON ARMOUR FOR SHIPS OF WAR.

By Mr. Norman S. Russell.

The problem of forming an iron fleet would at first sight seem a simple matter; for starting with the following facts proved by experiment—first, that 1in. thickness of iron breaks up shells so as to prevent their explosion as shells; secondly, that 2½in. thickness of iron stops them completely, and prevents the fragments of the broken shell from being carried through the ship's side like grape; and thirdly, that 4½in. thickness stops the heaviest shot fired from the most powerful guns which the science and manufacturing skill of this country have hitherto produced—it is only necessary that the vessels of the present wooden fleet, as they already exist, with engines on board, should be coated with the heaviest of these three thicknesses of iron which each ship is able to carry, and an iron-plated fleet will then be obtained. It is true that this immense fleet will cost more than a new and effective one of equal power; that not one of these vessels would be able to cross the Atlantic; that the entire fleet could not prevent a single fast cruiser from seizing all the gold ships on their way from Australia; and that they would not effectively blockade the coasts of any foreign power with whom there might be war; our supremacy at sea would be gone, but we should be safe from invasion, and able to stop an enemy attempting to land here.

This problem has already been tested with regard to the iron-coated French and English batteries. Several of them were built by this country and sent on their way to the Crimea; but after several disasters, and going as fast as they could under steam and sail, they got only half way, and returned to this country having done nothing; in short they were not sea boats. Such an iron-plated wooden fleet would be of a little more value than local batteries on shore, but only a very little; they could shift their position it is true, and provided it was known where an enemy intended to land, they could prevent his landing; but their advantage in this respect over land batteries would hardly compensate for their superior cost.

If it is desired to retain our supremacy at sea, a fleet must be formed that can not only fight a battle, but also ensure winning it. Such a fleet must be designed and constructed anew from the beginning; whether it shall be constructed entirely of iron or with wood backing to support the armour plates is still an open question; but in order to possess all the good qualities which are required in naval warfare, there can be no doubt that the structure of the vessels must be of iron. The real difficulty of the problem consists in this, that any existing ship of war when iron-coated will be slow, unseaworthy and combustible, and will be incapable of long voyages; whereas the fleet of England must be able to keep at sea for a long time, to steam long distances, to go faster than the ships of any other country, and to be in better condition than other fighting vessels in all weather, especially the worst. The whole difficulty consists in designing vessels possessing all these qualities in addition to being shot-proof.

To begin the consideration of an iron shot-proof fleet, by taking an example of a vessel which it would be wished to construct if possible; the question arises, can shot-proof gun boats, such as have hitherto been built be now built 140ft. long, 21ft. beam, of 80-horse power, and carrying 4 guns; and the answer is, they cannot be built, because the weight of iron would sink them. Even an iron-plated corvette of a favonrite class, 190ft. long, 36ft. beam, and drawing 16ft. of water, propelled by 250 horse power engines, could not be constructed. In short, to carry a high side out of the water, the ship cannot be much less than 60ft. beam; and to go with the requisite speed it must have a length of about 400ft.; it would then be a completely shot-proof iron ship worthy of the British fleet, but even this vessel would be 7000 tons burden. Smaller vessels can of course be built, but if they are to have good qualities, and are intended to act in concert with the more powerful vessels, they must be only partially coated and will be compromises.

The first ship of this class will be like the *Warrior*, shown in the accompanying illustration, Fig. 1; the next will be a smaller vessel with only the engines, boilers, and magazine protected; and the last will be a small shallow-water gun-boat, with one gun protected by a shield in front. But as far as a sea going fleet is concerned, the engines, boilers, and magazine must be protected; and it is this indispensable requirement which makes an effective ship of war really a very large one. It seems to be agreed that 14 knots an hour is the minimum speed of fighting vessels of war for the future; but this speed cannot be got in a vessel under 200ft. long, and for that purpose the lines must be very fine. In order to carry the engines and boilers, which must be protected, the ship must be 60ft. longer; and in order to carry also a coated battery of 10 guns it will have to be 40ft. beam; and even then the vessel is only partially coated.

It will thus be seen that the large size of vessels which are to be entirely coated, and the mere partial coating of smaller vessels, are equally inevitable. Both are the results of unalterable laws, in the adoption of which there is no choice. This point has to be insisted upon the more strongly, because the question has sometimes been considered as if both the size of vessels and the extent and natnre of their armour were matters of free choice. Such vessels are inevitably of enormous cost, and therefore too much pains cannot be bestowed on their mechanical design and the strue ture and durability of their armour.

The consideration of armour resolves itself into three principal questions first, what is the best kind of armour merely to resist the impact of shot for which purpose the armour may be considered to be simply hung on the side of the ship, in no way contributing to the strength of the structure but merely as dead weight hanging on the hull. Secondly, what is the best way of forming the structure of a ship entirely of iron, with a view of employing the whole strength of the iron for the purpose of rendering the structure of the ship as strong as possible; making the vessel only so far shot-proof as the nature of the structure will admit, and considering resistance to shot a secondary object. In the first of these methods armour plates are hung on an already finished ship; in the second a ship is built up of thin plates in such a way that these plates may afford as much protection as their weight can give. It remains to be considered, however, thirdly, whether the thick armour plates and the thin ship plates could not be so combined together in the structure of a ship as to give that ship all the benefit of them both as armour plates and as integral parts of the strength of the ship.

The first of these questions is easily disposed of. In the original floating batteries of 1854 an ordinary wooden hull of a ship was covered with iron plates weighing about 3 tons each and 4in. thick, tacked on by through bolts of 1½in. diameter, slightly coned and countersunk on the outside with nuts on the inside, perforating of course the sides of the vessel. It is in this simple and rude manner that the six vessels now building by the Admiralty are coated over, with 4½ and 5½in. armour plates. The armour of the French wooden vessels is also fixed in this manner, except that wood-screws have been substituted for through bolts and nuts, as shown in Fig. 2, which represents a section of the armour of *La Gloire*, the first constructed of the armour-plated ships.

The *Warrior*, the first English armour-plated ship, is also coated on this principle, as shown in Fig. 3, which is not affected by the circumstance of this vessel having an iron skin.

The first reliable experiments made in this country on armour plates were those againt the side of the *Trusty*, in 1859, of which Admiral Halsted has left a valuable record. The armour, shown in Fig. 4, consisted of 4in. iron plates fastened to the side of the vessel, which was equal in scantling to that of a 90 gun ship. The general result of these experiments was that out of more than 25 shots, fired from Armstrong, Whitworth, and ordinary 32 pounder guns, only two shots pierced the armour at the joints of the plates, and these were then so spent that they dropped on the deck of the ship without reaching the other side. It is not known that any experiments were made on the armour of *La Gloire*; no doubt the actual experience gained from the iron-coated floating batteries at Kinburn was considered of more value than any which could be obtained from firing against a target under circumstances that could scarcely occur in actual warfare.

The *Warrior* target, Fig. 3, like the plating of *La Gloire*, was based upon the experience goined by the French floating batteries at Kinburn, and ½ inch was added to the thickness of the plates as an allowance for the improvements in artillery, making 4½in. total thickness. The plates were wider, and the iron skin was placed behind, forming the side of the iron *Warrior*. This target was subjected to the fire of the ordinary Armstrong and smooth-bore guns; the plates were driven in from the bolt heads and were bent and buckled in a manner that proved their admirable qualities, but the bolts were not broken, except when struck by shot, and the skin remained intact. This was the great triumph of armour plating, which proved that the iron-coated ships then in existence were invulnerable under circumstances very unlikely to be reached in an actual naval battle. Subsequently experiments were tried with the 156 pounder gun, and the three shots fired at the target punched a clean hole through the armour plate, and lodged in the backing, but did not penetrate the iron skin behind.

In the second method of constructing iron war ships, the best structure of the ship exclusively has been kept in view, and it has been endeavoured by increasing the thickness of the structure to render it shot-proof, without sacrificing any of the materials for that purpose but retaining the use of their whole strength in the ship. This was a very likely course for either an engineer or shipbuilder to follow, and those who took up the subject from a mechanical point of view have more naturally adopted this system which may be called the structural system; while the artillerist took up the former former plan of simple iron armour, neglecting structural considerations. The principal applications of this second system are shown in Figs. 5, 6, and 7.

Experiments on armour plates were made in the United States at the beginning of the present century by Mr. Stevens, the father of the present system of armour-plated ships; and the "Stevens Battery" shown in

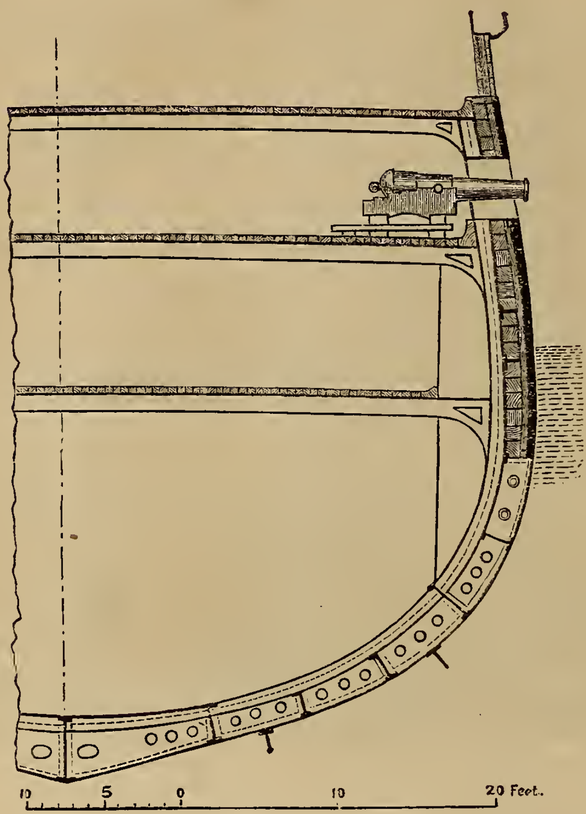


Fig. 1.—Section of Warrior.

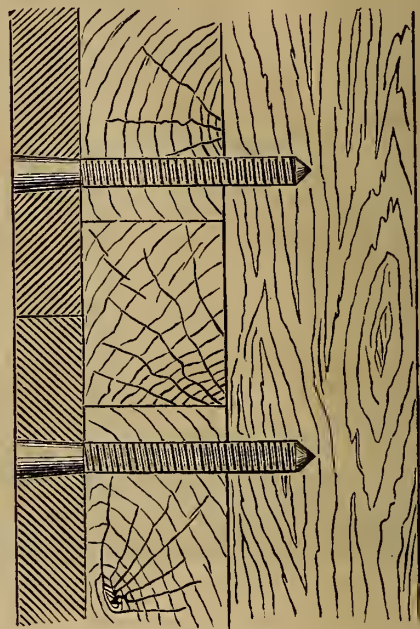


Fig. 2.—La Gloire.

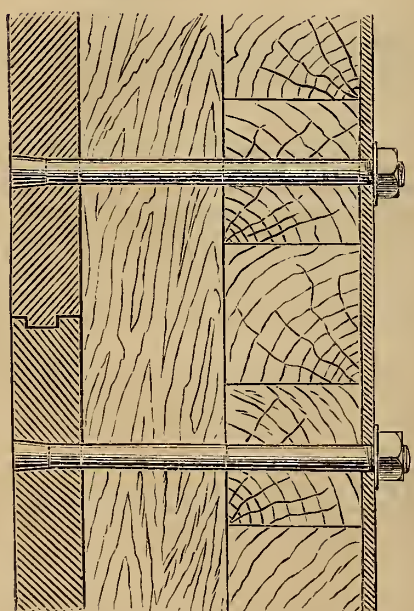


Fig. 3.—Warrior.

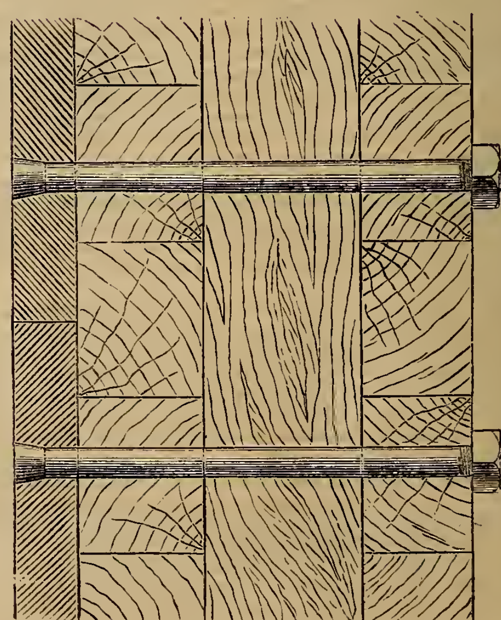


Fig. 4.—Trusty.

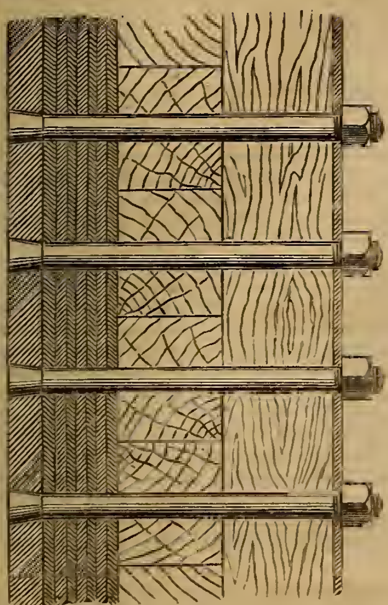


FIG. 5.

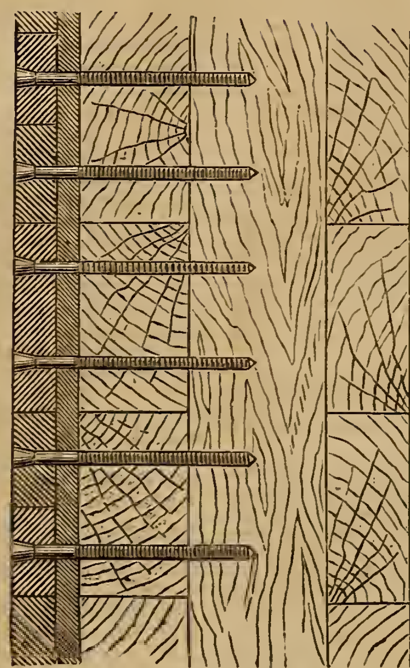


FIG. 6.—MERRIMAC.

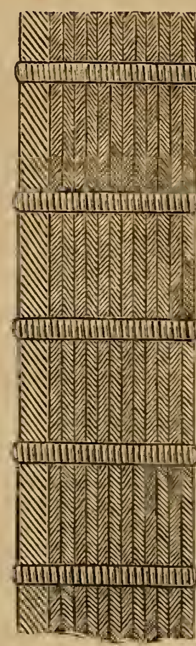


FIG. 7.

FIG. 8.

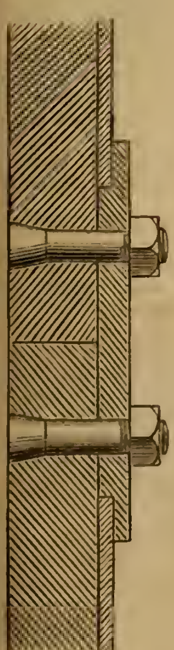


FIG. 9.

FIG. 10.

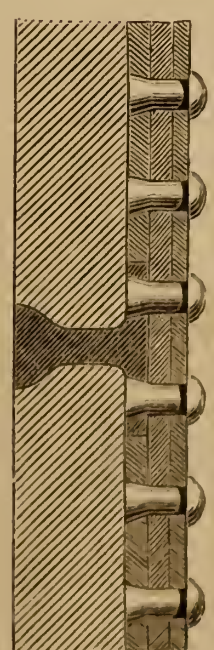


FIG. 11.

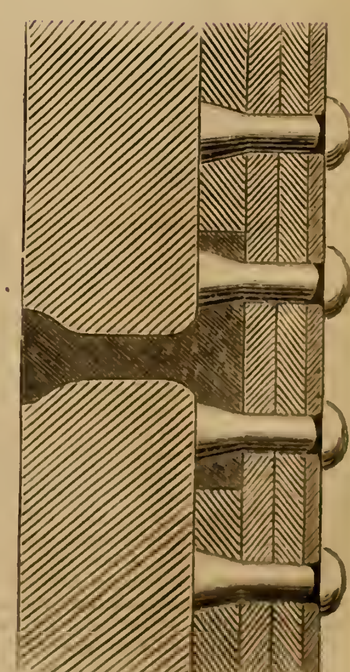


FIG. 12.

in section at Fig. 5, was coustructed at a later period by the American Government in consequence of those experiments. The ship was only half finished when its construction was discontinued; but since the agitation of this question in America several experiments have been tried to test the peculiarities in the construction of this vessel, by subjecting a target of similar construction to the fire of the heaviest American naval guns. Tbis armour is 6¾in. thick in all, being composed of 2-in. plate with a number of ¾in. plates behind it. The Stevens Battery, like the *Warrior*, is an iron ship, and between the iron skin and the armour there is a timber backing of 14in. of locust timber. The target was placed on a slope of 27½° to the horizon, and fired at from a distance of 220 yards by a 10-in. service gun weighing 88 cwts., and subsequently by a Parrot rifled gun of 6½in. bore weighing 86 cwts. The shot from the 10-in. service gun was solid spherical shot weighing 124lbs., with a charge of 11lbs. of powder. The deepest indentation made by this shot in the armour was 1¾in. Only 100lbs. shells were fired from the Parrot gun, with 10lbs. of powder, and they made indentation only 1 inch deep. The slight effect produced upon the Stevens armour must be attributed to the great angle at which it was placed and the low velocity which 124lbs. shot would have when fired with only 11lbs. of power. The Americans, however, still believe that a number of thin plates properly backed are better able to resist shot than one plate of equal thickness, which can only be considered to arise from an inability at present to forge or roll thick soft and homogeneous plates of large dimensions.

The armour of tbe *Merrimac*, shown in Fig. 6, although it was designed simply for resisting shot, must necessarily, from its peculiar formation, add to the strengtb of the ship. It was not formed as is generally supposed of railway bars, but in a manner much more effective and ingenious. Bars of iron 6in. wide and 1½in. thick were placed vertically on the side of the ship, and another outer layer of bars of the same width but 2½in. thick crossed the lower layer at right angles, the whole being bolted at each intersection to the side of the ship by ⅞in. bolts or screws. This armour seems to have stood remarkably well against the heaviest shot of the ships of war to which it was exposed, but fired at low velocities; for as far as it is known, no shot fired from the *Congress* or the *Monitor* pierced the side. It forms probably the cheapest armour that can possibly be constructed, and has been introduced for fortifications by Captain Inglis, where weight is of no consequence and cost is everything. In the armour for ships of war, however, the case is precisely reversed.

In Fig. 7 is shown a section of the target constructed by Mr. Hawkshaw, who was one of the first to see the important advantages to be derived from the substitution of a structure of thin iron plates in place of the thick armour plate with wood backing, provided an equally effective resistance to shot could be obtained. This target consisted of twelve ¾-in. plates with a 2in. plate on the outside, forming 11in. thickness of iron altogether, tbe whole being rivetted together or tied by 1¼in. screws tapped tbrough all the plates at 8in. pitch. Only a few shots were fired at the target, but the trial of it was a valuable experiment, and the result proved that future ships of war could not be formed of thin plates alone, though the question of iron backing still remained open.

Having now considered armour without strength and strength without armour, the third method of construction comprises the plans devised in the belief that nothing but thick armour plates perfectly solid can be shotproof. In this conviction it has been attempted to counect the iron armour directly and immediately with the iron hull of a ship, so as to avoid wood backing with its rapid decay, its bad fastening and its bad structural qualitie,s and so as to make the entire hull and armour one homogeneous mass of iron, that it may as a wbole, possess vast strength and great durability. When this is done, tbe enormous cost of a fleet of large vessels will not be perilled by the chances of premature decay, and the ships will not be burdened by useless loads of material. Three plans have been tried for this purpose. One is that of the Iron Plate Committee who were to try the question of iron against wooden backing. A second plan adopted by Mr. Samuda may be called the thick plate structure, because it takes the tbick plates of the armour and by scarfing them from the inside, builds the upper part of the bull from the armour plates, so that they form the ship itself. The third plan by Mr. Scott Russell may be called the incorporation structure, because the bull of the ship is here built up quite independent of the armour, and recesses are prepared in this structure into which the plates are let as into cells, and the edges of the cells are then rivetted down over the plates in such a manner as to incorporate the plates into the previously existing structure; by this plan the backing and fastening form parts of the ship, and the armour plates communicate as much strength as one uninterrupted rivet all round the edge can give them.

The Iron Plate Committee, knowing the advantages to be derived from the substitution of an iron for a wooden backing, designed the iron target, shown in Fig. 8, which in every way except the wood backing was on the same principle as the *Warrior* target. The bolting was tbe same in principle, and there were ribs at the back; the only difference being that a little less material was put into the skin and a little more into the ribs. The result proved the utter insufficiency of the bolting, since 8 out of the 46 bolts holding on all the armour plates snapped off at the first round. It also proved that an iron target formed in this manner was not an improvement on tbe *Warrior* target so far as resisting shot was concerned. The target would probably have stood much better if the backing and framing had been exactly the same as in tbe *Warrior* and had had 2⅝in. of backing with 10in. frames, instead of only 1in. skin, and ribs of twice that depth.

In Fig. 9 is shown the target next experimented upon, designed by Mr Samuda. It differed from that of the Iron Plate Committee in having 5½in. plates, and having a very different system of framing; the chief peculiarity being a strong thick plate at tbe edges of the armour, through which the numerous 1⅝in. bolts or rivets were fastened. Tbe framing of this target proved inferior to that of the previous one, but the plates curled up in a much less degree, and stood better, excepting at the edges where they were weakened by the bolt holes.

In Fig. 10 is shown the target next tried, constructed on Mr. Scott Russell's plan of continuous rivetting, wholly of iron, and introducing the principle of fastening the plates without bolts. The armour plates of 4½in. thickness, are fitted in between wrought iron bars of the same depth, wbich run longitudinally and vertically along the ship's side and form part of its structure. These bars are heated at the outer edge and hammered down over tbe edges of the adjacent armour plates, in such a way as to form one continuous rivet passing all round the edge of eacb plate. There are several other plans for holding plates without bolts, which differ only in their practical execution from that now described, but their principle is the same, and the trial of this may be considered in effect as a trial of tbem all. The result of experiments proved that the fastening stood perfectly, and that an iron target could be constructed entirely of iron wbich could prevent the 156lbs. shot fired with 50lbs. of powder from passing through the armour.

The author then proceeded to submit the following conclusions, viz.:—In the first place a thick plate must be employed on the outside of the target. As much of the armour as practicable should be put into the structure of tbe ship, but it must have a thick plate on the outside. The plate must not only be a thick one, but it must also be a wide one; in other words the fewer cracks in the armour to begin with the better. The large plates are of course very expensive, and it would be highly satisfactory if smaller ones could be made to do as well; but the 68lb. shot insists upon large armour plates if it is to be kept outside the ship.

The next fact, which is common to armour backed with wood, and armour backed with iron, is that every bolt hole weakens the plate. A large bolt hole does not weaken it more than a small one; and if bolting is found to be the best mode of fastening, the bolts should be large and there should be few of them. The holding of the plate is of more consequence in an iron than in a wooden target, for this reason, that the iron plate is driven bodily into the wood and the only purpose which the fixing serves is to keep the plate from absolutely falling off. It would prove a very instructive experiment and would not cost much to have the *Warrior* itself subjected to the same test as its section at Shoeburyness, and then sent to sea to try the effect of the rolling of the ship upon the loosened plates; the dockyards would also have an opportunity of finding out the easiest and most efficient method of repairing such a iron fleet.

It seems very remarkable that in the construction of armour plating, such different mechanical proportions should have been adopted from those of other iron constructions, and that while 1in. plates would be fastened together with 1¼in. rivets or bolts, a large plate 20ft. long, upwards of 3ft. wide, and weighing more than 5 tons, should be fastened on by only fifteen 2in. bolts. Mr. Samuda's target was far less injured and far less changed in general shape tban that of the Iron Plate Committee, for the simple reason that there were a larger number of bolts to hold the plate to the skin; but they were unfortunately so close together that a couple of shots happening to strike the edges of the plates where they were weakened by the holes, one of tbe shots went clean through. In Mr. Scott Russell's target, constructed on the principle of fastening without bolts, the face of the target was less disturbed. The area of fastening or bolting to a given plate on this principle is 12 times that of Mr. Samuda's and 25 times that of the Iron Plate Committee's target.

The effect of shot on a target having wooden backing is to expend all its force on the armour plate, which is twisted and bent and curled up at the edges, but the iron skin remains intact. In the iron target, on the other hand, the skin and backing divide the work with the armour plate, and while the skin is broken through, the armour plate remains but little injured; and probably, although several shots did go through the two iron targets, if the firing were continued on them as well as on the *Warrior* target, the latter would be smashed in long before either of the former.

Whenever, therefore, ships come to be built entirely of iron, as will be the case at some future time if not now, it is submitted that they must have the following qualities: the armour plates must be wide, there must be no bolts, the fastenings must be large, and there must be an inner skin to prevent the pieces of iron from flying among the crew. Sucb an armour

will then be superior in resisting power to that of the *Warrior*, adding to the strength of the ship instead of detracting from it, having a skin uninjured and independent of the armour; and it will cost nothing for repair, but will last for ever.

It is important to glance at the power of shot fired at high velocities to penetrate iron armour, and the capabilities of the iron armour for resisting solid shot. Not much is known positively respecting this, but the following facts are tolerably well ascertained: that the 110lbs. Armstrong shot has a velocity of 1200ft. per second, the 68lbs. shot a velocity of 1580ft. per second, and the 156lbs. a velocity of 1700 feet per second; and that these shots have respective penetrating powers of 158, 170, and 430. It is also believed that, while the penetrating power of shot is as the square of its velocity, the resisting power of a plate is as the square of its thickness. This has not been absolutely proved by experiment, but is probably not far from the truth, and any error is due to the difficulty of manufacturing thick plates as homogeneous as thin ones. Assuming then the two following data, that the 68lbs. shot just does not pierce a 4in. plate, and that the 156lbs. shot just does not pierce a 4½in. plate, backed by 3in. of iron, it can be determined approximately what thickness of plate and backing would be required to stop a given shot having a given velocity, and what size of vessel would be needed to carry such armour and also to possess all the qualities necessary in a ship of war. At present the shot fired from the most powerful gun yet made is stopped by a 4½in. armour plate and 3in. backing of iron, and the vessel necessary to carry such armour is of 7200 tons burden, and has a displacement of 10,500 tons, a saving in weight of 600 tons being here made by the adoption of the iron backing.

TABLE OF DIMENSIONS OF VESSELS TO CARRY DIFFERENT THICKNESSES OF ARMOUR.

	4½-inch armour.	7-inch armour.	11-inch armour.
Length of vessel	400 feet	500 feet	600 feet
Breadth	60 feet	70 feet	80 feet
Tonnage	7200 tons	12000 tons	20000 tons
Horse-power of engines	1800 h.p.	2000 h.p.	3000 h.p.
Weight of engines	1800 tons	2000 tons	3000 tons
" armour	2000 "	4300 "	10000 "
" hull	2000 "	3700 "	5000 "
" coals	4000 "	5000 "	7500 "
" armament	700 "	1000 "	1500 "
Total displacement	10500 tons	16000 tons	27000 tons
Weight saved by adoption of iron backing	600 tons	1500 tons	4000 tons

Although however no shot has penetrated the strongest armour hitherto made, guns will doubtless be made to pierce it, for an Armstrong gun is now being manufactured to throw a 300lbs. spherical shot, and guns will probably be made to throw 400 and 500lbs. shots. On the other hand, although 4in. armour is no longer invulnerable, it must not be considered that the thickness of armour cannot be increased because a vessel could not carry the additional weight; and the writer wishes to show that when the more powerful guns are manufactured and used in large numbers not only can the shot be stopped by armour of reasonable dimensions, but this armour can be carried by vessels of such moderate dimensions as to offer a fair prospect of the race between armour and artillery being continued for the next twenty or thirty years. Thus taking the gun now in progress for throwing a 300lbs. spherical shot, which may be assumed to have a velocity of 2000ft. per second at a range of 200 yards, this shot may according to the preceding data, be stopped by a plate 7in. thick and backed by 4½in. of iron, as shown in (Fig. 11). The minimum vessel required to carry such armour from end to end would be of 12,000 tons burden and would be propelled by engines of 2000 horse power at a speed of 15 knots per hour; 1500 tons weight would be saved in the construction by the use of iron instead of wooden backing. Assuming still further that a gun is made to throw a spherical shot weighing 500lbs. having a velocity of 2500 feet per second, such a shot could on the same data be stopped by 11in. armour plates backed by 8 inches of iron, as shown in (Fig. 12), and this armour could be carried from end to end by a vessel of 20,000 tons burden and 3000-horse power, which would be under the size already attained in the Great Eastern. A comparative calculation of these vessels is given in the accompanying table.

It must be borne in mind that these vessels are coated from end to end; and smaller vessels can be made, but they must be only partially coated with these heavy plates. It will thus be seen that the days of armour-plated ships do not end with 4½in. armour, but that there will always be a race between armour and artillery: defence has up to the present time had rather the best of it, but that will not last long. It is only to be hoped that it may long remain a friendly race between artillerists and constructors of armour.

INSTITUTION OF CIVIL ENGINEERS.

ON AMERICAN IRON BRIDGES.

By MR. ZERAH COLBURN, C.E.

The great number of timber bridges in America might be accounted for from the fact, that the first cost of the truss or superstructure of a timber bridge of any given span, was generally less than one-half that of an iron bridge of the same strength. Iron had been occasionally employed since 1835, but only within the last ten or twelve years to any extent.

Cast-iron tubular arches, including one of 80ft. span, were erected from the design of Major Delafield, about the time when similar arches were adopted by the late M. Polonceau, in the construction of the Pont du Carousel, over the Seine. Major Delafield's arched ribs were elliptical in section, the transverse vertical axis being about four times the length of the conjugate axis. In 1858, an aqueduct bridge was erected at Washington, by Captain Meigs, in which the two arched ribs were formed of water pipes, through which the water flowed. The span of this bridge was 200ft., the rise being 20ft. The pipes were circular in section, 4ft. in diameter inside, and 1½in. thick. This bridge was 28ft. wide over all, and the roadway was of timber, supported on wrought-iron spandrils. The bridge was tested with the arched ribs filled with water, and with a load of 125lbs. per square foot upon the roadway, making the total weight on each rib about 350 tons. The thrust of one-half of this weight upon each abutment would be about 470 tons, corresponding to a strain of 2 tons per square inch of sectional area of iron in the pipes. This strain did not include the pressure of the water in the pipes, which were proved to 300lbs. per square inch. These examples were, so far as the Author was aware, the only iron arches yet completed in the United States: and with the exception of a few pivot bridges, and one or two ornamental bridges in the Central Park at New York, they comprised nearly all the cast-iron bridges in that country.

There were a small number of plate, or boiler iron bridges. The first was erected in 1847, in place of a timber bridge, by Mr. Millholland, on the Baltimore and Susquehanna (now the Northern Central) Railroad. This was 50ft. span, and the two girders were each 6ft. deep, the two sides of each being formed of plates ¼in. thick. Between the sides at the top a timber 12in. square was bolted as a compression member, and the top was further strengthened by two wrought-iron bars, 5in. deep by ¾in. thick, while four similar bars were rivetted along the bottom of each girder. The sides were stiffened by stay-bolts, enclosed in cast-iron distance pieces, 12 inches apart from centre to centre. The centre of each girder was placed exactly under the rails, which were spiked to the timber forming the compression member. The breaking strain of the pair of girders was equal to 259 tons of distributed load, and the weight of the bridge was 14 tons. When completed, this bridge was coupled at each end to a railway waggon, and was slung by chains to a temporary timber truss. It was then taken 19 miles by railway, run exactly over the place it was intended to occupy, the existing timber bridge was cut away, and the girder bridge lowered with the permanent way ready for traffic; the whole operation not having caused an interruption of more than two hours.

Having been long accustomed to trussed timber bridges, American engineers, in adopting iron, naturally employed it in trusses also. But, before describing the various forms of iron truss bridges, the strength of American iron was referred to. It appeared from a vast number of experiments made by the United States Ordnance Board, that there was but little iron in any American cast guns of a less tensile strength than 11 tons per square inch; and in 1851, the Author had himself seen portions cut from 11in. guns, weighing 6 tons 15 cwt., tested up to 16·14 tons. The transverse breaking strength of a large number of samples of re-melted iron, when reduced to the English standard of a bar 2in. deep and 1in. wide, resting on supports 3ft. apart, varied from 27¾ cwt. to 48·1 cwt., the general strength being 34 cwt. The minimum crushing strength of the irons experimented upon was 37¾ tons and the maximum 77¾ tons. Experiments made by the Franklin Institute twenty-five years ago, showed the mean tensile strength of cast-iron at the first melting to be 9¼ tons; and the iron now employed by engineers in Philadelphia bore from 7·14 tons to 10·2 tons. In 1858, Mr. Albert Fink tested the iron used in the construction of a large bridge on the Louisville and Nashville Railroads. When the results were reduced to bars 2in. deep by 1in. wide, on supports 3ft. apart, the minimum breaking weight was 29½ cwt. mean 32·08 cwt., maximum 39 cwt. This iron was a mixture of two-fifths cold blast, two-fifths hot blast, and one-fifth scrap. With regard to wrought iron, experiments made by the United States Board of Ordnance gave a tensile strength varying from 17 tons to 33·3 tons per square inch; and those of the Franklin Institute, a mean strength of 26 tons for plate iron. At the present time 27 tons was generally expected of American boiler plate. Other ex-

periments were also quoted to the same effect; and it is remarked that, from what had been stated, American engineers might work up to rather higher strains than were commonly allowed in this country. The high qualities of the best American iron were due to the purity of the ore and of the fuel employed in the manufacture. In bridges of less than 150ft. span, even when loaded with a weight of 1·36 ton per lineal foot of single line, the strains did not exceed 3·57 tons per square inch on wrought iron in tension, and 4·46 tons per square inch on cast-iron in compression.

Of the iron truss bridges that were described, all had certain peculiarities in common, distinguishing them from the trussed structures adopted in this country. In almost every case the compression members of American iron trussed bridges were of cast-iron cylindrical or octagonal pipes. These simply abutted, end to end, against each other; and although means were employed to prevent lateral motion of the ends, flanges and bolts were never introduced for that purpose. Another, and one of the most important peculiarities was the depth of truss, a depth exceeding that employed by English engineers, except in rare instances, as at Chepstow and at Londonderry. American engineers considered a depth of one-eighth for spans of 200ft. as only moderate; for shorter spans depths of one-seventh and one-sixth were common; and in the case of one bridge of 120ft. clear span, the depth was 23ft., or nearly one-fifth of the span. It should, however, be observed that, in some of the American trusses, the arrangement of the tension members was such that, if the depth of the truss were not considerable, the diagonals would be inclined at hardly more than 8° or 10° from the horizontal; in which case a very large quantity of material would be employed, in proportion to the supporting power obtained. No American iron or timber bridges were ballasted; nor had they any floor, only a foot-path of planks. In bridges having the rails at, or above the level of the top chords, known in the States as "deck bridges," parapets were seldom employed; and the trusses were often so short a distance apart, that a passenger, on looking out of a carriage window, was unable to discover any support beneath the train. In no bridges of two or more spans were the trusses made continuous over a pier; each span being always treated as a bridge by itself.

One of the earliest iron trusses adopted in the States was a trellis, known as Rider's Bridge. Cast-iron T, or angle-irons, were employed in compression, and wrought-iron bars in tension. These bridges were so slightly proportioned that they occasionally broke down, and the Author was not aware that the plan was now adopted in new structures.

A detailed description was then given of a Murphy-Whipple bridge, having a span of 125ft., with the railway supported on the lower chords. It was for a double-line, and there were three trusses, 14ft. apart, from centre to centre, the strength of the middle one being about one-half greater than that of either of the others. The trusses were 23ft. deep, or 0·184 of the span. The top chord was formed of cylindrical cast-iron pipes, and the bottom chord of a chain of square bars, 10ft. 5in. in length between the centres of the eyes. Upright cast-iron posts, placed at the same distances apart, divided the truss into panels, and as the posts were in two lengths, they were each trussed by four round rods, to prevent lateral failure. The diagonals were in pairs of square rods, and were formed also as eye-bars, grasping pins 2½in. diameter in the top chord, where the pipes abutted upon each other, and pins 3½in. diameter in the bottom chord, thus connecting the links, or bars, of which it was composed. The diagonal tension bars only crossed each other in two panels on each side of the centre of the truss. The top and bottom chords were braced horizontally, with transverse and diagonal bars. The railway bars were supported upon longitudinal timbers, which rested upon transverse wrought-iron rolled beams. The total weight of the superstructure complete was 102½ tons, or 8 cwt. per foot of single line. With an additional distributed load of 3000lbs. per lineal foot on each line, the tensile strain at the middle tension rods would be 4·27 tons per square inch in the middle truss, and 3·12 tons per square inch in the outer truss; but, with a train on a single line only, the ordinary working strains did not exceed 2½ tons per square inch in tension, nor three tons in compression.

In 1861, an iron bridge was erected on the line of the Pennsylvania Central Railroad, across the Schuylkill at Philadelphia. It had two clear spans of 192ft. each, and one pivot span, or turning bridge 122ft. long. The construction was similar to that just described, but the truss was only 19ft. deep. The upright posts or struts, were of wrought-iron, so rolled that when two bars were put together they formed on octagonal tube. The top and bottom chords of the turning bridge were of wrought-iron rolled beams, so that either might resist extension or compression. The three spans for a single line contained an average of 5 cwt. of wrought-iron, and 7½ cwt. of cast-iron per lineal foot. The nett cost of the bridge, exclusive of masonry, was £8144 10*s*., or £14 4*s*. per lineal foot; the wrought-iron costing £22 15*s*. 6*d*., and the cast-iron £6 11*s*. 3*d*. per ton.

The pivot was of a kind extensively employed for turn-tables. It consisted of a fixed and of a movable cast-iron disc, both grooved to receive a number of steel rollers, each turned to the frustra of a double cone. A circular railway was laid around the pivot, but the wheels only bore upon it, when the bridge was not truly balanced on the rollers. With a load of 14 tons balanced upon one of these bearings, the whole was revolved by a weight of 3½lbs. hung over a pulley, and connected by a cord to the periphery of the turn-table.

The form of truss introduced by Mr. Wendel Bollman was next noticed. In it the load upon each panel was transferred directly to the ends of the truss, through a pair of straight suspension bars, doing duty only in that panel. With the exception of one pair of suspension bars, supporting the centre of the bridge, the bars in each pair were of unequal length, and their lower ends were attached to the upper extremity of a compensating link, in order to allow for contraction and expansion. This bridge could not alter its form under unequal loading. A bridge upon this plan at Harper's Ferry, on the Baltimore and Ohio Railroad, had four parallel trusses for a double line, and a clear span of 124ft. The span was divided into eight panels, and the depth of the truss was 17ft. 6in. The top chords were each formed of a single line of octagonal cast-iron pipes, and the vertical posts were also of cast iron. The strains upon the various parts of the truss caused by the weight of the bridge, and of a load of 1½ ton per lineal foot, were 2·1 tons per square inch in compression in the top chord, and varied from 4·36 tons per square inch in tension in the longer suspension bars to 7·14 tons in the shorter bars. Mr. Bollman had stated, that this bridge was tested with a moving weight of 122 tons of locomotives on one span of a single line, or nearly 1 ton per lineal foot, and that the deflection at a speed of eight miles an hour was 1⅝ inch at the centre.

The iron bridge designed by Mr. Albert Fink had been more extensively adopted than any other on the railways of the United States. In this bridge a pair of diagonal tension bars connected the foot of the principal strut or king-post in each truss, with the ends of the top chord. This pair of diagonal bars supported one-half of the whole weight of the truss and its load. Each half span was subdivided by a strut, and two diagonal tension bars extended, one to the nearest end of the top chord, and the other to the top of the centre post. Each quarter span was again subdivided into eighths, and these again, for spans greater than 100ft., into sixteenths. Under the direction of Mr. B. H. Latrobe, then engineer of the Baltimore and Ohio Railroad, in 1852 Mr. Fink erected an iron bridge of three spans, each of 205ft., where that line crossed the Monongahela river. The depth of the truss was about one-ninth of the span, and the railway was carried at a little above the level of the bottom of the truss. The weight of the bridge including the permanent way, was only ½ a ton per foot of single line, and with an additional load of 1 ton per lineal foot, the tensile strains upon the wrought-iron did not exceed 5·15 tons per square inch, and the compression on the cast-iron 4·25 tons. The Green River and the Barren River Bridges were then alluded to as being identical in construction to that last described.

The Bollman and Fink trusses for a single line, and in spans of from 160ft. to 200ft., cost £14 per lineal foot, or nearly £28 per ton; while timber bridges of the same span only cost from £5 to £7 per foot. Still, iron bridges now met with an amount of favour, which appeared certain to insure their ultimate substitution for timber bridges. A gradual preference was being shown to the plate girder, as the great annual range of temperature, from 20° below zero to a reflected heat of 130° in the summer sun, was not favourable to the use of cast-iron in structures of such importance as railway bridges.

ACCOUNT OF THE COFFERDAM, THE SYPHONS, AND OTHER WORKS, CONSTRUCTED IN CONSEQUENCE OF THE FAILURE OF THE ST. GERMAIN'S SLUICE OF THE MIDDLE LEVEL DRAINAGE.

By Mr. Hawkshaw (President Inst. C.E.)

The St. Germain's Sluice was situated at the confluence of the Middle Level main outfall drain with the River Ouse, near the upper end of the Eau Brink Cut. This drain was made in 1847, from the designs, and under the direction of Messrs. Walker, Burges, and Cooper. It was deepened by them in 1857, and then had, at the lower end, a bottom width of 48ft., the side slopes being 2 to 1. The level of the bottom was 7ft. under low-water spring-tides in the river, and the rise of the tide at that point was about 19ft. at spring-tides, the cill of the sluice being 6ft. below low-water spring-tides. The bed of the drain was of soft blue clay, and the sides consisted of variable thicknesses of soft blue clay, peat, yellow clay, and surface soil.

On the 4th May, 1862, the St. Germain's Sluice gave way, thereby admitting the tidal waters, which ebbed and flowed throughout a distance of upwards of 20 miles. A few days afterwards, the western bank of the Middle Level drain burst, about 4 miles from the Sluice, by which 6000 acres of land were inundated. Immediately after the failure of the sluice, the Author received instructions to execute whatever works might be necessary to shut out the tidal waters, regardless of expense. The services of Mr. J. T. Leather were secured as Contractor, who was ably aided by his assistant Mr. E. P. Smith. Mr. Alexander G. Linn was appointed resident engineer. Subsequently, after the cofferdam was closed, finding it impossible to devote so much time to the works as he had previously done, at the Author's request, the Middle Level Commissioners associated with him Mr. T. E. Harrison, who had since continued to act.

Before the author assumed the direction of the works, and directly after the failure of the sluice, an earth and cradle dam was attempted to be thrown across the drain, at about 500 yards from the fallen sluice. This was relinquished shortly after the permanent cofferdam, of pile-work, was commenced; which the Author considered was the only plan likely to be effectual, and the site finally fixed upon for which was about 880 yards from the sluice. The cofferdam might be thus described:—Temporary piles were first screwed into the ground, upon which a staging was erected for the pile-driving engine. Two rows of sheet-piling, 25ft. apart, were then driven transversely down the slopes of the drain on each side, from the centres of the banks to within 20ft. of the bottom, leaving a central space of 88ft. of cofferdam to be afterwards completed. In this portion of the dam the piles were placed in pairs on each side, 7ft. 6in. apart from centre to centre, and with a space of 7in. between each pair. The grooves thus left were for the reception of sliding panels, to be used to fill up the intervals between the several twin piles. Waling pieces of whole timbers were fixed to the inside and the outside, both at the top and as near the level of low water as possible. As the piles were driven, struts and ties were inserted, and strongly-framed raking struts were secured against the dam and against abutments of piles, backed with concrete, on the land. The panels were composed of timbers 7in. thick, and of variable lengths, firmly bolted together, and further connected and weighted on one side by flat wrought-iron plates. In order to put these panels in place, a frame was erected, from which they were suspended, and from which they could be lowered, and raised, if necessary, by pulleys.

The rush of water through the dam was materially increased, while the piles for the panels and the walings were in place; so that, at times, the difference

of level between the water on the two sides of the dam was considerable. Aprons, extending the whole width of the drain, aud for some distance up the slopes. were formed ou both sides of the dam, of sacks of clay, and of gravel, puddle, and stone. Only sufficient stone was deposited iu the centre of the dam to stiffen the clay; but large quantities of puddle were repeated thrown in at slack water, most of which was washed away by the rush of water, which acquired a velocity of 8 miles an hour.

The first, or lower tier of panels was 7ft. deep, aud poiuted at the lower end, so as to be driven into the mud. Inasmuch as they could not be driven to the same depth, the second set was so arranged as to raise the panelling to the uniform hight of low-water spring-tides. During these operations, sacks of clay and gravel were deposited on the inside and the outside of the dam; but, although the aprons were extended, only a few sacks of gravel remained in the inside. It now became clear, that the water could only be excluded, by shutting the dam at one operation. To accomplish this, the necessary panelling, which had to be 12ft. deep, was suspended from the scaffolding, so as to be dropped into place at slack-water neap-tides, when the differential head for the dam to sustain was the least. On the first attempt to close the dam, three of the twin piles on the lower side gave way, releasing some of the bottom panels, after the tide had receded 3in., and when there was a head of 8ft. The other panels were readily lifted and removed; and sheet-piling was theu driven up to the level of the lower waling pieces, thereby filling in the spaces between the broken piles. The second attempt, which proved completely successful, was postponed until the succeeding neap-tides, when the panels were dropped iuto their places in twenty minutes, at low-water of ebb tide, that time being more convenient, the difference of the head at high and low water not being considered of sufficient importance to counterbalance other advantages. After the panels were lowered, the inside of the dam was immediately filled with clay: sacks of gravel and clunch being deposited in the centre. So complete were the arrangements, that the raising of the dam was kept in advance of the rise of the tide, and before high water, the operation was completed, the dam not exhibiting the slightest indication of failure, or of weakness. The cofferdam was commenced on the 16th of May, and the tidal waters were shut out on the 19th of June, 1862.

During this time, the means to be adopted for the future drainage of the Middle Level received serious attention. After careful consideration, the author determined that, in addition to such drainage as could be obtained through Salter's Lode Sluice, the old outlet into the Ouse, syphon pipes should be laid over the cofferdam. This plan of discharging water was not to him novel, having pursued it in 1839, when engaged on the Manchester, Bury, and Bolton Canal. The syphons were sixteen in number, and were laid transversely across the dam, at an inclination of 2 to 1 at the sides, and horizontally over the top. Each end was terminated by a horizontal length, containing the upper and lower valves, laid 18in. under low-water of spring tides, the top of the syphons being 20ft. above the same level. The total length of each syphon was 150ft. The syphons were of cast-iron, 3ft. 6in. internal diameter, and the thickness of the metal was (excepting at the socket ends, where it was thicker,) 1⅛in. They rested on the top of the dam, and on inclined framework, supported on piles, at the sides. Underneath the extreme ends of the syphons, sheet-piling was driven across the drain. Above the sheet-piling, the spaces between the inclined framework, to the underside of the syphons, were filled in with clunch, clay, and gravel, so as to form a solid and impervious embankment. The bottom of the dam, at the inlet and outlet of the syphons, was protected by substantial wooden aprons, extending across the drain; and a row of piles was driven on each side, inclining towards each other, and contracting the channel to a width of 60ft., so as to keep the "wash" off the slopes of the drain. The upper or inlet, valve consisted simply of a loose hanging flap of teak wood, working inwards as soon as the outward was the preponderating pressure. The lower, or outlet, valve was of cast-iron, turning on a hinge at the top, and fitted with a balance weight, which was capable of resisting an interior pressure, but could be readily released when the valve was converted into a flap opening outwards. The reason for adopting two valves was for the purpose of enabling the syphons to be put into operation, either by exhausting the air, or by filling them with water; but at present only the former method had been tried.

The syphons were put into action by exhausting the air from the inside, by an air-pump having three cylinders, each 15in. diameter with a length of stroke of 18in., worked by a 10 H.P., high pressure, steam engine. Each syphon could be shut off, or be brought into operation at pleasure, by means of slidecocks, fixed on vertical pipes, communicating with a transverse horizontal pipe, in connection with the air-pump. An overflow pipe showed when the syphons were full of water; and glass gauges were also attached to some of the syphons for the same purpose. The pipes were cast by Messrs. Cochrane and Co., and the steam engine and air-pump were manufactured by Messrs. Easton, Amos, and Sons.

After the breach occurred, it became evident that all attempts to stop it should be abandoned. The area flooded was surrounded by banks, which confined the mischief within certain limits. As soon as the cofferdam was completed, and the tidal waters were excluded, the breach was closed, by first tipping stone to form a footing for an embankment of clay to the level of the bottom of the drain, above which a small quantity of clunch was mixed with the clay, to stiffen and weight it. The total quantity of material used to restore the bank was about 2500 cubic yards. The bottom of the drain, where the scour had taken place, was also repaired, and the banks generally were put in good order. After the breach was secured, the water on the inundated land was let off, through the Marshland Smeeth and Fen drain and the adjoining Marshland sewer.

In conclusion, the author remarked, that he believed the syphons would be found to answer all the purposes of a permanent sluice. They possessed, moreover, the advantage of not rendering the safety of a district dependent upon single pairs of gates; for it was clear, that any one or more of the syphons might be damaged or destroyed, without affecting the operation of the others, or endangering the district.

In an Appendix, tables were given, showing the quantities of the several materials used in the coustrnction of the dam and the syphons, as well as the resnlts of the working of the syphons.

ON THE COMMUNICATION BETWEEN LONDON AND DUBLIN.

By Mr. Watson, M.A., Assoc. Inst. C.E.

Holyhead, the nearest poiut of land iu Great Britaiu to the metropolis of Ireland, was naturally thought of at an early date as a couvenient port of departure and arrival for the mails. This route had accordingly been used for a century and a half, and was recognised in an Act of Parliament passed in 1729; but the communication between London and Dublin was then irregular, and the time occupied ou the journey protracted. Travelling through North Wales was attended with difficulty and fatigue, and the passage of the Channel was contingent on the state of the weather. Though measures of improvement were proposed before the close of the last century, no effectual steps were adopted, until after the legislative uniou had takeu place between Great Britain and Ireland, in the year 1801. The public commissious were constantly engaged iu iuquiries, and committees of the House of Commons presented no less than twenty-five reports on the subject within ten years. These investigations had reference, principally to the land part of the journey; and by means of large grants of public money, amounting, it is believed, to nearly oue milliou sterling, in 1826 a continuous and easy road was completed between Londou and Holyhead, so that the entire distance of 267 miles could be performed, with regularity, safety, and comparative comfort, iu thirty-four hours. Improvements for the sea-part of the journey also engaged some degree of attention; but while sailing vessels were in use, it was not thought that much could be gained in the passage of the Chaunel. In 1819, a steam-vessel was placed on the Holyhead station for the summer aud autumn, and soon afterwards the *Royal Sovereign* and the *Meteor* were especially built for the Post Office service, with engines by Messrs. Boulton and Watt, and then the sailing cutters disappeared. The average length of the passages of these two steam vessels, in the first year, between Holyhead and Howth, was seven hours and thirty-three minutes; the shortest passage was made in five hours and forty-eight minutes, aud the longest was stated to have occupied upwards of twenty-three hours.

The mail communication between London and Dublin had been thus long maintained exclusively by way of Holyhead; but the rapidly-growing importance of Liverpool led to the establishment, in 1826, of a direct postal service between that port aud Ireland. Steam vessels had been placed on that station, by private enterprise, as early as 1819, for the conveyance of passengers during the summer months; and in 1823, Mr. C. Wye Williams (Assoc. Inst. C.E.) originated a company for the maintenance of a regular steam communication throughout the entire year, for the conveyance of passengers and of merchandise. As the railway from London to Liverpool was opened in 1838, that line became for some years the most expeditious route to Dublin, and the mails and passengers nearly deserted Holyhead. Liverpool did not long, however, retain this superiority; for, in 1849, a continuous line of railway was completed between Loudon and Holyhead, by private capital, twenty-three years after the continuous line of road had been constructed, by direction of the state, and principally by grants of public money. The conveyance of the Irish mails was then transferred from Liverpool to Holyhead, and the large and powerful packets of the Government and of the Company, which had carried the night mail under contract for the previous ten years ou the Liverpool line, were appropriated to other duties.

During the time these changes were in progress, the packet service was transferred from Howth to the Asylum Harbour at Kingstown, which was ultimately connected with Dublin by a railway six miles in length. The only link then remaining to complete the communication with Ireland was a superior class of vessels. The Government having decided on building four vessels each of 700 tons burthen, with engines of 320 horse-power, the best result was admitted to have been attained; as the rate of speed of the *Banshee* at the measured mile was upwards of 18 statute miles an hour, or nearly four miles in excess of any previously obtained. After a short trial of this service at heavy cost, the Lords of the Admiralty determined that it should be performed by contract, as had previously been the case on the Liverpool line, and that the average speed should be 12 knots, or nearly 14 statute miles per hours. This service lasted from May, 1850, until October, 1860, and was performed within the stipulated time.

Further improvements being still demanded, a plan was submitted to Government, and a new postal contract was entered into, the main provisions of which were, first, that the entire distance between London and Kingstown, instead of to Dublin, was to be performed in eleven hours, allowing four hours for the sea passage; secondly, that four steam packets should be specially built for the service; thirdly, that express trains should be appropriated exclusively to the Irish traffic; and fourthly, a morning and evening departure from each capital. The vessels referred to were each 2000 tons burthen, and in their dimensions and general arrangements were nearly identical. Three, the *Connaught*, the *Ulster*, and the *Munster* were built by Messrs. Laird, and the one, the *Leinster*, by Mr. Samuda. The ships were of iron, timber having been used only for the decks and cabin fittings. The length of the *Connaught* between the perpendiculars was 334ft., the beam was 35ft., and the depth 21ft. There were nine principal water-tight bulkheads, which not only provided for the safety of the ship in case of accident, but added greatly to the strength. The bulwarks were of iron plates, in continuation of the sides of the vessels, without any break for gangways. Between the paddle-boxes there was an upper deck, which further added to the strength amidships; and on this was placed the wheel and binnacle. The entire of the main-deck, from the foremost funnel forward, was covered by a hurricane-deck, which had been found of great advantage in throwing off seas in heavy weather. The engine in all the vessels were on the oscillating principle. Those for the *Connaught* and the *Leinster* were made by Messrs. Ravenhill,

Salkeld and Co. The cylinders were 98in. in diameter, and 6ft. 6in. stroke, the air pumps being 54in. in diameter, with a length of stroke of 2ft. 6in.; the boilers were multitubular, eight in number, four at the end of the engine-room space, arranged in pairs, with one funnel to each pair; there were five fire grates in each boiler, and the total grate surface was 677ft. square, the heating surface exceeding 19,000ft.; the wheels were 31ft. in diameter to the outside of the floats, which were feathering, fourteen in number, and each was 12ft. long by 4ft. 4in. broad. On the trial trips, the engines worked at the rate of 25½ revolutions per minute, with 25lbs. of steam. The mean of the runs of the *Leinster* at the measured mile was 20½, and of the *Connaught* 20⅝ statute miles per hour. The engines of the *Ulster* and the *Munster* were constructed by Messrs. James Watt and Co.; the cylinders were 96in. in diameter, with a length of stroke of 7ft.; the wheels were 33ft. in diameter; the boilers had each six fireplaces, giving an equal extent of grate surface with the other; the heating surface measured 18,033 square feet; these engines were erected on board the vessels in the Liverpool Docks, and from a return of observations made on several trips, there being no measured mile at that port for testing speed, the rate attained appeared to have been 20½ statute miles per hour. One of the principal peculiarities, which made these vessels of so unique a class, was the post-office fitted for sorting letters on the passage, so that the letters were ready for delivery, or to be forwarded to their destination, on the arrival of the vessels, either at Kingstown or at Holyhead. About two hours were thus saved in the transmission of the mail.

The contract with the Postmaster-General had appointed January, 1861, for the commencement of the improved service. But as the vessels were in readiness some months sooner, it was commenced in October, 1860, and had since been continued without interruption. From what had been already stated, it would have been seen, that the difference of speed between the four vessels on the trial trips was inappreciable—a matter of paramount importance to a mail service. Thus, while the shortest passage of the *Connaught* across the Channel occupied three hours and fourteen minutes, being at the rate of about twenty miles an hour; the shortest passage of the *Leinster*, the *Ulster*, and the *Munster* were three hours and twenty minutes, three hours and eighteen minutes, and three hours and twenty-two minutes respectively; their average performance for the two years and five months during which they had been on service, inclusive of the trips made in fogs, gales, &c., was still closer, as follows:—

				Hrs.	Min.	
The *Connaught*	made	1064	passages in	3	51½	on the average
„ *Leinster*	„	919	„	3	52½	„
„ *Ulster*	„	925	„	3	55	„
„ *Munster*	„	920	„	3	58 1-10ths	

The consumption of coal in the first few months was considerably in excess of the quantity originally estimated. Steam of from 25lbs. to 28lbs. pressure was then used; but satisfactory arragements had since been made to reduce the consumption, while the additional time occupied on the passage was but a few minutes, and was still within the time allotted to the sea service; the engines in the *Ulster* and the *Munster* had been provided with superheaters, but experience had not shown any advantage, either as reducing the consumption of coal, or as tending to a superior performance. These vessels had made in the aggregate 1845 passages, in the average time of 3 hours 56½ minutes, and had consumed 30 tons 7 cwt. of coal as the average of each, inclusive of the quantity required for raising steam, which was considerable. The *Leinster* and the *Connaught*, without superheaters, had made 1838 passages in the average time of 3 hours 54 minutes, and had consumed, inclusive of raising steam, on the average, 30 tons 1 cwt. of coal.

It was satisfactory to be able to state that the ships had, so far, needed no repairs, being now in as perfect a condition as when the service was commenced, in 1860. The frequency of docking, for the purpose of cleaning and coating, had afforded constant opportunities of examination, when painting only had been required.

In conclusion, the author referred to the admirable performance of the land portion of the journey, from London to Holyhead, by the London and North-Western Railway Company; the punctuality in the arrival of the trains on the jetty at the latter place, the speed maintained, and the excellence of the carriages, were the subject of universal approval. Further improvements, at present not thought of, might yet be brought into operation; but there appeared to be no reason for apprehending that the communication by way of Holyhead would ever cease to be the best for postal purposes, and to be preferred by the travelling public, so long as the entire distance between London and Dublin could be accomplished within eleven hours and a half.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

NOTE AS TO TWO EVENTS IN THE HISTORY OF STEAM NAVIGATION.

By W. J. Macquorn Rankine, C.E., LL.D. F.R.S.

(1.) An interesting paper was lately read to this Society by Mr. Dyer, containing a history of a series of important events in the progress of steam navigation.

(2.) It is to be regretted, however, that the author has noted either very slightly or not all, what appears to have been an event of paramount importance in the first adaptation of the double-acting cranked steam engine to drive a paddle-wheel. Before that adaptation was made, the success of all attempts at steam navigation, such as those of Jouffray, Rumsey, Fitch, Miller, and Taylor, &c., had been only temporary, because of the rudeness of the machinery for communicating motion from the piston to the shaft.

(3) That first adaptation was unquestionably accomplished by William Symington in 1801, as is proved by authentic documents which have been published by Mr. Woodcroft in his *Origin and Progress of Steam Navigation*. Symington, instructed by the failure of the ratchet-work engine which he had made for Miller's boat, fitted up the *Charlotte Dundas* in 1801. with a double-acting horizontal cranked engine, and this made her what Mr. Woodcroft justly called "the first practical steamboat." Her speed, when running alone, and not towing other boats, was six miles an hour.

(4.) The use of this vessel was abandoned, not from any fault in her construction or working, but because the Directors of the Forth and Clyde Canal feared that she would damage its banks. Yet the man in all Britain who possessed, at that time, the greatest practical experience of the working of canals—the Duke of Bridgewater—was not deterred by any such apprehensions from ordering, in 1802, *eight* similar vessels, from Symington, to be used on his canal.

(5.) The death of the Duke of Bridgewater, early in the following year, prevented the execution of that order. But Symington had evidently done all that lay in his power, and all that was necessary, to convert the steamboat from an awkward piece of experimental apparatus to a practically useful machine; and the honour paid to his memory ought not be lessened because the career of his invention was cut short by a misfortune.

(6.) There is nothing in this to detract from the honour which is justly paid to Fulton, as having been the first to practice steam navigation on a great scale, as a commercially profitable art.

(7.) Another event passed over in the paper to which I have referred, is the first introduction of commercial steam navigation into Europe, which was effected on the river Clyde, in 1812, by Henry Bell, as is proved by documents cited in Mr. Woodcroft's work, already referred to.

ON THE INTRODUCTION OF STEAM NAVIGATION.

By Mr. Dyer.

In Dr. Rankine's paper, entitled "Note on two Events in the History of Steam Navigation," he calls attention to my paper, "On the Introduction of Steam Navigation," and expresses regret that "the author has noted either very slightly or not at all, an event of paramount importance:—the first adaptation of the double-acting cranked steam engine, to drive a paddle-wheel." Now, I own to have taken no notice at all of this double-cranked motion, simply because I did not consider it of much importance in attaining success in steam navigation. I had before me Mr. Woodcroft's interesting treatise, and I fully appreciated his advocacy of the claims of Mr. Symington for having fitted up the *Charlotte Dundas*, as the first practical steam boat, in 1801. This fact is fairly stated in my paper.

I aimed to place before the Society the several inventions and discoveries relating to the use of steam power to supersede that of wind to navigate vessels, and to prove that the final success was due to the invention of Watt's steam engine. No great stress need be laid on the double-cranked action, or on any of the other methods used for transmitting the power to the paddle wheels. The principles involved in overcoming the resisting forces by steam power in navigation, are entirely apart from those relating to the mechanical means of converting rectilinear into circular motion. It seems strange that such able engineers as Dr. Rankine and Mr. Woodcroft should have given this prominence to the said double-crank action. Whatever may have been the degree of success in the case of the *Charlotte Dundas*, in 1801, and whatever may be said about the bar to further progress of Symington's inventions by the Duke's death, the fact remains clear that his schemes died out with the Duke, as no more was heard of them after the *Charlotte Dundas*, and from some cause, she was discontinued; and it was in fact fifteen years after her advent before the *Margery* came out from the same waters to enter the Thames in 1816. What shall be said of the enlightened of Glasgow, if Symington's practical steamboat was suffered to rot and be forgotten, leaving no successor, and the inventor himself to remain unrewarded and unnoticed for fifteen years.

Through the limited space allowed for the abstract of my paper, Dr. Rankine was misled respecting the other event, also cited by him from Mr. Woodcroft's book, namely:—that I had passed over the first introduction of steam navigation into Europe, by Henry Bell, in 1812; for in my paper due notice is taken of this well known experiment of Mr. Bell. Although his trial boat proved a failure, on account of its being a very small one, and of his want of pecuniary means for continuing or extending the experiment, and the lack of any aid or encouragement afforded him by others, yet his trial boat served as the model for constructing the *Margery*, three years after, which, as I have before said, was a success, and the first steamboat on English waters. I therefore think that due honour should be paid to the name of Henry Bell, for his spirit and enterprise, and a due stigma cast upon the capitalists who allowed him to sink under pecuniary pressure, from which he ought to have been relieved by them in so important an enterprise.

THE LONDON ASSOCIATION OF FOREMEN ENGINEERS.

NEW MARINE PROPELLER.

At a well-attended meeting of this Society, held on the 2nd ult., Mr. Joseph Newton, of H.M. Mint, President, read a paper on a "New Mode of Marine Propulsion," suggested by Mr. Vaile. The extreme length to which the paper extended renders it impossible for us to do more than summarise the chief features of Mr. Vaile's proposed plan.

Mr. Vaile proposes to apply to ships or boats one or more submerged endless chain propellers, with feathering floats. The latter would be adapted in form, number, and dimensions to each particular vessel to which they might be applied. Such is briefly the character of the invention.

Mr. Newton stated, it might be objected at the very outset that there was nothing of novelty about Mr. Vaile's scheme. A closer examination and inquiry would demonstrate the reverse to be the fact. Mr. Vaile's propeller possessed features which distinguished it sufficiently from all previous plans of an analogous kind. Those features mainly consisted in the shape of the floats, their mode of attachment to the travelling chains, their perfect and simply effected feathering properties, and the total submergence of the entire apparatus when in action.

Mr. Newton stated, that by enlarging the chain wheels of the Vaile propeller, increased breadth might be given to the floats. Their breadth might, indeed, be always made to equal the diameter of those wheels minus the diameter of their shafts, and a few inches of clearance between the shafts and the upper edges of the acting floats. Thus, for instance, if wheels of 10ft. diameter were used with shafts of 12in., and 6in. of clearance were allowed, the floats would be 8ft. 6in. broad, and as long as the beam of the vessel would permit.

As in a ship expressly constructed for the reception of this kind of propelling apparatus, one propeller would be placed on either side the keel, and nearly as low down, it was contended that the floats travelling with equal velocity, and having a direct thrust aft, must be far more effective than either screw or paddle-wheel.

It had been found in practice impossible to drive a ship at high rates of speed without incurring the penalties of excessive expenditure of power and fuel. This fatal evil was due principally to the inadequate area of propelling surface in proportion to the bulk and weight to be moved. With the screw, the amount of acting surface was limited by the keel and water-line. With the paddle-wheel it was governed by the size of that wheel, which again was restricted to a reasonable diameter. No such limitations existed with the Vaile propellers. These admitted of the employment of a number of floats of equal area, and ensured them always acting simultaneously upon the water. The floats, too, might be of much greater depth and length than those of the ordinary paddle-wheel. A perfect correspondence will, indeed, be established between the power given out by the engines and the media for receiving and dispersing that power—the floats.

This could never, or at least had never been the case with either screw or paddle-wheel. The evils of "slip," so considerable in the action of both its competitors, would be economised by the Vaile propeller. It was well understood that although by the agency of the screw, and by that of the paddle-wheel, a speed of from ten to fifteen knots had been obtained, yet that if a higher rate of speed was attempted, the result was most unsatisfactory. The slip, at all times great, now became enormous. It increased in a much greater ratio than the speed of the vessel.

The lowness of the position of the Vaile propellers gave them, in the matter of slip, a strong claim to superiority. The floats obtained thereby a hold on the densest water, through which the vessel moved, and would thus *at all times* act with their full propelling force. Increased speed must follow the application of increased steam power, and slip could not increase in a greater ratio than the ship's velocity. Constant submergence, constant action, and perfect feathering were the ruling characteristics—the alleged advantages of the chain propeller of Mr. Vaile.

Both screw and paddle wheel, when in a heavy sea were from alternate direction and deep submersion, frequently ineffective, and to use a nautical but expressive phrase they both at such times "ground up" the power of the engine without producing the "push-a-head" effect required. Mr. Newton remarked that there was no grinding up of power with the Vaile propellers, they were calculated to absorb the full power of the engines and to give it out with perfect effect. Mr. Newton then proceeded to say the power of steering and manœuvring a vessel independently of the rudder's action, was gained to a considerable extent by these propellers. By driving one ahead and the other astern, the ship might be turned in her own length as on a centre.

PROPOSED CONNECTION OF THE INDIAN AND RUSSIAN RAILWAY SYSTEM.

This is a project broached by Russia and seriously entertained by English engineers, of connecting the Indian and Russian system of railway communication by the Oxus valley and the Caspian. Taking the map, it will be found that the swiftest and almost direct route between Calcutta and London is from Raneegunge to Buxar, there cross the Ganges, and through Oude and Rohilcund to Umballa, joining the Punjaub Railway to Lahore. Thence a fine road leads to Peshawur, and a tunnel under the Indus at Attock is more than half bored. Leaving India, the Khyber Pass is gone through, past Jellalabad and Cabul, through the Hindoo Koosh, and striking on the Oxus, following it as far as Khiva, whence there will be found the ordinary caravan routes to the Caspian, where a Russian steamer waits. Arrived at Astrakhan we shall find in a few years the St. Petersburg Railway completed by Sarata, on the Volga, to that city, and from Lemberg by Kiev to the same place. The route is two days shorter than by the Euphrates Valley, or eight days in all from Calcutta to London. The only difficulty is between Peshawur and the Caspian, and the only engineering trouble would be the Hindoo Koosh. It will be more easy to make a railway in Centrel Asia than along the Ukran coast, where Alexander's army perished, and where it is difficult to protect a line of telegraph. It is not to be expected that the Euphrates Valley line will go further than Bussorah for many years, any more than the Caspian line further than Astrakhan and Peshawur on either side.

REVIEWS AND NOTICES OF NEW BOOKS.

Steam in the Farmyard: Its adaptation to Agricultural Purposes. London: W. Kent and Co. 1863.

Notwithstanding the obtrusively evident advertising character of this pamphlet crops out in nearly every page, and the business object with which it has, doubtless, been written becomes perfectly recognised, there is is so much that is true and valuable for the purpose of refereuce, upon a subject on which so very much remains to be written and done—practically and systematically—that we feel justified in calling the attention of our readers to the pamphlet. It is full of interesting figures and details, showing the economy attending the substitution of steam in the farmyard and in the field. The General Steam Cultivation Company, upon the direction of which the names of his Grace the Duke of Sutherland and other eminent and extensive landed proprietors will be found, appears to have been originated to obtain a sufficiently large capital for the purpose of supplying upon lease, or to sell upon agreements for payment by instalments, the more expensive steam machinery proposed to be employed for the cultivation of land and for performing the manufacturing operations connected with the farmyard.

A Record of the Progress of Modern Engineering, &c. Edited by W. HUMBER, Assoc. Inst. C.E., and M. Inst. M.E. London: E. and F. N. Spon, 1863. Parts 3, 4, and 5.

Mr. Humber's *Record* certainly improves in quality and excellence. He has made a very interesting selection of works for illustration in the more recently issued parts.

A Short Explanation of the Analytical and Universal Nautical Code of Signals. By Count D'ESCAYRAC DE LAUTARE. London: J. Camden Holten, Piccadilly, 1863.

The Author proposes a very comprehensive, simple, and ingenious system of signalling at sea, which is deserving of the attention of nautical men.

The Science of Ship-building considered in its relation to the laws of nature, by H. BOWLBY WILLSON, Esq., of Canada. London: J. D. Potter, 31, Poultry, 1863.

The author has strung together, in some ninety-eight or one hundred paragraphs, which are not very well assimilated or connected, much that would be very valuable to naval architects or ship builders, after more care has been bestowed upon the present disjointed and crude mass of matter presented by the author. What Mr. Willson goes in for as a midship section of a sea-going ship, is the square, box-like form; and for long, broad, and shallow ships, *strengthened* by a longitudinal bow and string girder. "By this method the ship's keel will become the basis of strength for the whole structure, both longitudinally and transversely, instead of looking to the outer walls, as is now done, for the main support"—*(p. 45)*. Now, as to how new and how useful the "bow and string" contrivance is, the practical experience of many of our readers will enable them to judge of its usefulness, and one or two of them may have acquired that knowledge at a considerable cost. Otherwise, in many respects Mr. Willson has, upon questions of construction and disposition of materials, and the internal and general arrangements of both cargo, ships, and vessels of war, reproduced, to a great extent, the plans of Mr. R. Roberts, Capt. T. R. Symonds, and others. We are, nevertheless, much obliged to Mr. Bowlby Willson for the aid which his pamphlet must give in helping along the common cause of all who are interested in the progress of naval architecture, &c., by ventilating the subject more fully. Mr. Willson, in his preface, pays a well-deserved compliment to a very promising young naval architect, Mr. Thomas Smith, of Randolph, Elder, and Co.'s shipbuildin yard at Glasgow,

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.
To the Editor of The Artizan.

HEAT AND FORCE.

In all machines it is observed that a considerable loss of power results from friction, and a corresponding production of heat takes place. This production of heat may be fairly considered as the equivalent of the force lost by the friction of the machine.

By agitating a liquid, its temperature is increased because the movements of the mass are changed into molecular movements, by the friction of the particles on each other, and on the interior surfaces of the containing vessels.

As it is an undisputed fact that work can thus be directly converted into heat, the mechanical theory of heat supposes that, conversely, heat is changed into work. In the steam engine heat is obviously the cause of work, but it is by no means evident that part of the heat is actually changed into work, as the new theory supsoses.

It is argued that heat, or the intense molecular motion of ponderable matter developed by chemical agency in combustion, is the source of work in the steam-engine, and that perpetual motion would be realised if a given quantity of heat can, by its passage through the engine, perform exterior work, and still remain undiminished in amount at the end of the operation.

The force of this reasoning depends on the view which is taken of the constitution of the vaporous and gaseous states of matter. The mechanical theory of heat explains the constitution of vapours and gases, by the simple mechanical laws of matter and motion, without the agency of *repulsion,* as the word is generally understood. The legitimate scope of true philosophical inquiry should certainly be to clear away mystery, where possible, and to remove all unnecessary complication from our ideas of the agency of natural forces in the production of physical phenomena; but, unfortunately, the current theory of thermodynomics, by discarding the old idea of molecular repulsion in elastic fluids has introduced fallacies which seriously impair the practical value of an otherwise beautiful doctrine, elaborated with admirable skill by some of the first intellects of the age.

In former papers treating of this interesting subject, in connection with thermic prime movers, I have endeavoured to show that heat, as molecular motion, though the cause of work in the steam-engine, is not *directly converted* into work, and that all the heat which leaves the boiler in the steam should (theoretically) be found in the condenser, only more diluted, or of lower temperature. Such was the conclusion to which the large experiments of Segnin led twenty-five years ago; and Mr. Hirn, of Colmar, after the most elaborate research on the thermodynamical phenomena of the practical working of large steam-engines, not long since arrived at conclusions differing widely from the new theory. Fortunately for truth, the correctness of his valuable facts remains unimpeached, for it seems that M. Hirn has recently altered his views, and *given an interpretation to the facts of his experiments* more in harmony with the general opinion of scientific men, as more particularly enounced in the papers of Professor Clausius on the subject. M. Hirn's experiments showed that, besides the production of work without loss of heat, the tumultuous dashing of high pressure steam from the cylinder of an engine to the condenser produces an actual increase of thermometric heat; and the apparent absurdity of these conclusions disappears if we allow the obvious fact that high-pressure steam must contain some form of energy distinct from that of mere thermometric heat, as described by the thermodynamical theory, though always co-existent with it.

Sadi Carnot, in 1824, likened the dynamical action of heat in the steam-engine to that of water in a hydraulic wheel, the temperature of the steam representing height of fall in the water. Thus, a given quantity of heat concentrated into a smaller space would correspond to a given quantity of water raised to a certain height; the water in descending would produce work, and the heat expanding into a larger space would also produce work. The agents in both cases would remain the same in quantity, but it is evident that the water in its more elevated position contains an amount of work-producing power which it did not possess when at a lower level, and it must have required this work-producing power at the cost of so much energy expended from some other active source. This energy is obviously the equivalent for the work expended in raising the water. So, also, a given weight of low pressure steam, compressed by some exterior force into a smaller volume, contains more work-producing power than it possessed in the more expanded state; and this increase of work-producing power must have cost an equal quantity of energy transferred from the exterior agent. We cannot trace the occult process of the transfer, but the visible results prove that it has taken place, and we find that the energy thus transferred to the fluid has not increased its quantity of thermometric heat, as experiment proves that one volume of steam at ten atmospheres pressure contains the same (or very nearly the same) amount of thermometric heat as ten volumes of atmospheric pressure steam, that is to say, each will raise the temperature of a given mass of cold water the same number of degrees. Thus there is evidently a difference between thermometric heat and calorific energy in elastic fluids.

If we allow that elastic fluids may possess a property of molecular repulsion distinct from the molecular motion supposed to constitute elastic tension according to the current doctrine, we may conceive of the specific energy of high pressure steam as of the energy of a spring wound up; and common observation shows that when a vapour or gas is compressed, and the molecular springs are thus put into a state of greater tension, part of the latent heat of the fluid becomes sensible, and the temperature rises. And, on the other hand, when an elastic fluid is allowed to expand quietly by gradually enlarging the space it occupied, part of the sensible heat of the fluid becomes latent, and the temperature falls. Now, the chemical energy of fire applied to a common steam-boiler, besides effecting the change of the liquid to vapour, produces on the vapour formed the same result as compression from an external source of power. This will appear plainer by tracing the formation of steam in a boiler under gradually increasing pressure. Each fresh particle of steam formed increases the density of the steam already existing, and changes part of its latent heat into sensible; and if the first portion of the steam formed be supposed to remain in the upper part of the vessel unmixed with that which goes on forming below, it is perceived that its pressure will go on increasing with a corresponding rise of temperature caused by a change of its latent heat into sensible, independently of any direct communication of heat from beneath. The constitution of high pressure steam is obviously the same whether it is generated directly at high pressure in the boiler, or produced from low pressure steam compressed into a smaller volume by external force; thus it appears that a higher temperature in the heat absorbed in forming the steam produces the same effect as the application or transfer of energy from without in giving density and pressure. Therefore, the condition, or quality of the heat, should be considered in these investigations as well as the quantity.

Latent heat may be conceived of as a kind of polar arrangement of the particles of an elastic fluid, the angular distances of the like atomic poles increasing and decreasing with the distances of the particles from each other. The amount of latent heat which a liquid takes up in changing to a vapour is always proportional to the pressure, and the pressure is abviously as the space in elastic fluids, so that by increasing the pressure the apparent step between the two states of liquid and vapour is made smaller and smaller. The quantity of heat, or molecular motion, appears to be constant in the change of state independent of temperature or space. Therefore when vapour is formed at a low temperature, and corresponding low pressure, we may imagine the energy from the fire to actuate the particles in large orbits with few vibrations in a given time, and the like atomic poles greatly averted, consequently low repulsion; and, on the other hand, when vapour is formed at a high temperature, and corresponding high pressure, the same amount of communicated energy may be supposed to actuate the particles in smaller orbits with a greater number of vibrations in the same time, the angular distances of the like atomic poles being smaller, and, consequently, increased tension, or repulsive, force in the fluid. By some such hypothesis we can conceive the amount of thermometric heat in a given weight of saturated steam to remain constant under all changes of pressure and temperature, while the molecular repulsion, or calorific energy varies with the circumstances.

On a superficial view of the phenomena it might be imagined that, because the quantity of thermometric heat is the same in steam of various pressures, the increase of energy in high pressure steam costs nothing. Commercially speaking such is nearly the case, but in nature's laboratory everything must obey the laws of equivalence in phenomena of this kind, and there can be no doubt that the increased energy of the high pressure steam is produced by the transfer, or transformation, of some equivalent energy sent in from the fire; but as the temperature of common combustion is enormously higher than that of ordinary steam, and the temperature communicated to the liquid particles in becoming vapour is only the actual temperature of the steam, the *energy of concentration,* or high temperature in the heat, is availed of only in a very limited degree, and the greater part of it is allowed to run down and become diffused without producing the amount of dynamical effect which would result if it could be transmitted to the forming steam at a higher temperature.—J. Gill.

Obituary.

MR. BENJAMIN GOODFELLOW.

We regret to have to announce the death of Mr. B. Goodfellow, on the 29th of April last.

Mr. Goodfellow held a leading position in Hyde, and the neighbourhood of Manchester, during the last twenty years. He will be well known to most of our readers as one of our leading mechanical engineers, and by his numerous inventions affecting the various branches of engineering. He attained the high position which he held by dint of unremitting energy and industry.

Mr. Goodfellow was born of very humble but industrious and exemplary parents, at Rainin, a village in Macclesfield, in 1811. He commenced working in a silk mill at the age of six years—and after the removal of his parents to Hyde, he worked at the Carrfield Mills, Floweryfield, until 1838, during which time he worked upon all the machines needed in the manufacture of woollen cloth, and finally was employed as a mechanic, working upon the various machines used in spinning and weaving cotton.

In 1838 Mr. Goodfellow invented and patented his well-known metallic piston, the novelty of his invention consisting in the employment of three spring rings, producing both a vertical and a lateral action at the same time.

About the time of patenting his metallic piston, Mr. Goodfellow commenced business as a maker of them on his own account, at the Carrfield Mills, the use of the mechanics' shop being granted him by the proprietor of the Mills—the late Mr. Thos. Ashton.

He remained at Carrfield Mills about two years, and then removed to the site of the works on Mottram Road, where he gradually embarked in all the different branches of mechanical engineering, extending his works almost year by year since 1848 (in which year the chief portion of them was built) until they now stand on about 20,000 square yards of land, and when times are prosperous above 400 men are employed upon them.

THE RE-OPENING OF THE COLOSSEUM.

The Colosseum, with its numerous attractions, has been recently re-opened to the public under the management of Mr. J. Nimmo. During the time the building has been closed for the purpose of repairs, &c., advantage has been taken of the opportunity, to re-embellish the whole of the interior. The new management has been inaugurated by an attractive programme. It is announced that the present will be the last season of the exhibition of the moving cyclorama of the destruction of Lisbon by earthquake, and of the great pictures of London by day, and Paris by night.

NON-CONDUCTING COMPOSITIONS.

Mr. James Spence of Her Majesty's Dockyard, Portsmouth, has patented some excellent and very effective compositions, suited for covering steam boilers, cylinders, steam pipes, and other heated surfaces, for retaining the heat and preventing radiation.

As a substitute for the hair-felt lagging, &c., it is cheaper, and unlike hair-felt, it will perfectly withstand the highest temperature to which, by the introduction of the superheating of high pressure steam, the outer shells of boilers are now subjected.

By a variation in the proportions of the materials employed, Mr. Spence adapts the character of the composition to the various purposes to which it may be usefully adapted, whether for retaining heat, or excluding or resisting intense cold.

It has been tried with perfect success for several months, during which time we have had the opportunity of judging how admirably it is suited for the several purposes to which it has been applied; and, by its substitution for the present method employed for covering steam boilers in her Majesty's service. Not only will a great money saving be effected in first cost, and for renewals, but the danger arising from risk of fire will be avoided.

MR. RICHARD ROBERTS, C.E.

Messrs. Moira and Haigh, of Lower Seymour-street, Portman-square, have produced an admirable likeness of Mr. Roberts, of Manchester, and Messrs Marion and Co., of Soho-square, are the publishers. As a specimen of photographic art, it is excellent, and will doubtless be highly appreciated as a faithful likeness by all the friends of the worthy and highly talented original.

Twin-screw or Double-screw Steamships.—At the Royal United Service Institution, Captain T. R. Symonds, R.N., on Monday, the 18th of May, read a paper upon the advantages of manœuvring ships of war with broadside guns in action by means of two screws, worked by separate and independent engines, and compared it with the cupola system. The construction of ships, and the mounting and disposing upper deck guns of large calibre, proposed by Captain Symonds, enables fore and aft firing to be performed more perfectly than in any arrangement previously brought to the notice of naval artillerists, and, with the aid of the two screws, secures advantages not possessed by either the cupola system or any other plan of arming ships.

NOTICES TO CORRESPONDENTS.

Pater.—In answer to your enquiry, the Admiralty order to which you refer is very explicit as to the points. For your information we give the points *in extenso*:—

Engineer Boys and Dockyard Apprentices.

1. The vacancies for these appointments are open to public competition.
2. Candidates must not be under the age of thirteen years and nine months or above the age of fifteen years on the first day of the month after the examinations. Proof of age will be required by certificate of birth, extract from baptismal register, or declaration before a magistrate, which must be produced at the time of the examination. They must also produce evidence of respectability on a form which will be furnished by the superintendent. They will not be admitted for examination unless their age is within the above limits, and until they have been pronounced fit for her Majesty's service, by the medical officers in the yard, and they should possess the following qualifications at the minimum age:—

Height	4ft. 8in.
Weight	90lbs.
Girth of Chest	26in.

but a deficiency in these requisites will not exclude a candidate who may be pronounced by the medical officers to be generally calculated to make efficient workmen.

3. Examinations will be held in January and June.
4. The following will be the subject of examination, and the maximum number of marks for each subject:—

Arithmetical	350
Spelling	100
Handwriting	100
Reading	100
Grammar	100
English Composition	100
Geography	100
Euclid, 1st three books	150
Algebra, up to, and including quadratic equations; arithmetical and geometrical progression ...	150
Total	1250

5. A competent knowledge of the first four subjects will be required of all candidates, and candidates for the factories must also possess a competent knowledge of the first three books of Euclid, to render them eligible for appointment as engineer boys. The other subjects will count in the competition, but will not be considered essential.
6. 200 marks as a maximum will also be given for physical qualifications, viz., —height, weight, girth of chest, and strength.
7. The boys will be appointed according to their standing on the examination list, and the successful candidates will have the option of choosing vacancies for engineer boys in the factories, or for apprenticeship in the dockyards.
8. Candidates who fail at the first examination will be entitled to a second, if not over age.
9. All apprentices entered in future in the Master Shipwrights' Department, except millwrights, will be employed during the last two years of their apprenticeship, or part of that time, on board Her Majesty's sea-going ships in commission. They will receive their dockyard pay, with an additional day's pay per week for Sundays, and will be victualled on board, and receive tool money.
10. Apprentices receiving a superior course of instruction, if sent to sea, will be allowed to continue their studies under the naval instructor.
11. On the expiration of their period of service they will receive a certificate of their character and conduct, the progress they have made in their trades and in the knowledge of the subjects prescribed for dockyard apprentices. If this certificate be favourable it will receive due consideration, when any of these young men shall be candidates for promotion, either as carpenters' mates, or as inferior officers in the dockyards.
12. The apprentices now in the service will be allowed to avail themselves of these regulations on the recommendation of the Superintendents.
13. The engineer boys are not *apprenticed*, but are admitted to the factories for a period of about five years, with a view of becoming naval engineers should they, on examination, be found properly qualified, and should their services be required.
14. The list of candidates for the factories and for apprenticeship, is kept by the Superintendents of the dockyards, to whom all applications must be addressed. Persons serving afloat must apply through their commanding officers.

S.H.—Sketch received, and will be noticed in our next.

Z. C. and Others.—The water jet propeller may be seen daily on the River Meuse, and, we believe, also on some part of the Elbe. The plan there used differs from Ruthven's. Experiments are being conducted on some of the French canals with vessels having longitudinal trunks or water ways, through which the water admitted at the bows is ejected at the stern with considerable force, by means of rotary pumps.

Builders' Measurement, &c.—You will find what you require in the "Rudiments of Naval Architecture," by Peake, price 3s. (Weale's series), and "The Theory and Practice of Shipbuilding," by T. White, price 10s.; also by Weale, High Holborn; and, if you apply to Messrs. Spon, of Bucklesbury, they will forward you a series of books upon shipbuilding, and the various rules relating to measurement, &c.

J.H.—The pipe joint we should recommend for the purpose is that recently patented by Dr. Normandy, which effects a thoroughly tight joint. Should you use iron piping the same joint could be employed.

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

OPPENHEIM V. FRY.—This was a case tried in the Court of Queen's Bench, which raised an important point in the law of marine insurance,—whether the machinery of a steamer should be deemed part of the vessel, so as that the expense of putting out a fire in the hull should be recoverable as general average on machinery and hull, or be chargeable only against the hull. The policy was upon a steam vessel, valued at £22,000—that is, £14,000 for the hull and £8000 for the machinery—and the sum insured was £17,650; "average payable on the whole, or each, as if separately insured," 3 per cent. The steamer went to Constantinople, and while lying there near the shore a fire took place, which communicated to the hull of the vessel; and the sum in question was the amount of expense incurred in putting out the fire, which did not damage the machinery. When the owners came to claim upon the policy, the "average stater" stated the "particular average" at £386, in which, however, was included a sum of £9 for fees to Lloyd's surveyors for survey of the damage before the repairs; and, deducting that sum, there would be only £377. The other sum in dispute was thus stated as "general average." "Sundry expenses incurred in putting out the fire in order to preserve the ship from total destruction, employment of labourers, &c., £55," of which £35 was agreed to be the amount allotable to the hull, if it was a general average. The sum of £9 was stated as "particular average." Now, deducting the £9 from the £386 would leave £377, and adding thereto £55, would make a sum of £432, which would be, it will be observed, more by £12 than the amount of 3 per cent. on £14,000, the value of the hull. The average stater, however, stated the £55 as general average, out of which, in that view, only £35 out of the £55 would go to the hull; and adding this to the £377, would make up the sum of £412, which would be less by about £8 than the amount of 3 per cent. on the £14,000. The question in dispute (said to be important in point of principle) was, first, whether the £9 was particular or general average, and, next, whether the whole of the £55 should be allotted to the hull alone and be deemed particular average, so as to raise the sum above 3 per cent. A certain sum had been paid into court by the underwriters, and the question was if that was enough. If the amount in dispute were appropriated to general average, then the loss would be under 3 per cent., and the sum so paid would be enough; if to particular average, then the loss would be above 3 per cent., and the sum paid would not be enough. The case was tried at Guildhall, before the Lord Chief Justice, and the facts not being disputed, the question of law was reserved for the Court. The Court thought that the plaintiff was not entitled to calculate more than £35 of the £55 as particular average, and was not entitled so to calculate the £9, the expense of the survey, for the rest of the £55 and the sum of £9 were expenses incurred for the safety of the entire vessel. Thus, therefore, the loss would be under 3 per cent., and the plaintiff was not entitled to recover more. Judgment for the defendant.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

IRON TANK OIL SHIP.—The *Ramsay*, an iron tank-ship, built for the Petroleum Trading Company, recently sailed from Liverpool for New York. This vessel will carry about 400 tons of petroleum in tanks, and an equal quantity in barrels, and the system is so much approved by the underwriters that insurances can be effected on her at less than half the usual rates.

NEW FORTIFICATIONS.—The annual return relating to expenditure on fortifications states that the £2,000,000 authorized by the Act of 1860 have been raised, and £70,000 of the £1,200,000 authorized by the Act of 1862. These sums have been obtained by the creation of terminable annuities (1855), amounting to £133,827. The annuities were calculated at 3¾ per cent. interest. The amount actually expended up to the 31st of March last is as follows:—At Portsmouth, £764,729; at Plymouth, £393,870; at Pembroke, £134,975; at Portland, £122,134; at Gravesend, £78,463; at Chatham, £122,242; at the Medway and Sheerness, £125,463; at Dover, £190,718; at Cork, £21,493; on experiments, £1,318; land surveyors' charges, £10,414; surveys and legal expenses, £35,465; officers, surveyors, clerks, draughtsmen, &c., employed, and contingent expenses, £40,165. Total, £2,041,449.

SUBTERRANEAN FOREST.—During the progress of the Victoria Dock extension works at Hull, a subterranean forest has been struck at a depth of 32ft. from the surface. In one instance the root and part of the stem of an immense oak, about 20ft. in circumference, and in a good state of preservation, lies exposed, and, as it is on a level with the bottom of the dock, it will probably continue in its original position until the end of time. The remains of the trunks of two other large trees have also been dug up, one of which bears the evident marks of fire. In some instances the wood is mixed with clay, and mostly as black as ebony, and when cut by the workmen's spades, soon crumbles into dust by the action of the air. The forest appears to have been of a very great extent, for at present no limit has been found to its boundaries. Wherever the excavations are continued, the workmen discover traces of its existence. It may not be uninteresting to describe the geological condition of the strata. Clay is found to about 15ft. below the surface, and beneath that a seam of sand, which is followed by a stratum of sand of a moister nature, greatly mixed with cockle and other fresh-water shells, and then comes the seam containing the wood, wetter still.

TIN LINED LEAD CISTERNS.—At a meeting of the Liverpool Chemists' Association on the 7th ult., specimens of lead pipe and sheet lead, electro-plated with tin, were exhibited by Mr. Holt, and some discussion ensued respecting the use of lead coated in this manner for water cisterns and pipes. It appeared to be the opinion of the meeting that the coating of tin, instead of preserving the lead, was far more likely to insure its more rapid corrosion, for if the coating of tin by any means happened to be scratched off, even to the slightest extent, galvanic action would take place, and the lead would be destroyed very quickly. Dr. Nevins and Dr. Edwards stated that their experiments had proved that such would undoubtedly be the case, Dr. Edwards remarking that, in one case which he had examined, a cistern made of lead, in which was an accidental admixture of tin, was eaten out by well water in six months, the lead being rapidly precipitated in the form of sulphate, &c.

PARIS TO BE LIT BY ELECTRICITY.—The lighting of Paris, it is stated, is to be entrusted to M. J. Von Malderan, who has invented a new electric light, one jet of which is equal to 2200 jets of gas. The Place Saint Surplice is destined to be the first where the essay is to be tried.

TRIAL OF AN HYDRAULIC PRESS.—The official trial of Messrs. Westwood, Baillie, and Co.'s new 28in. hydraulic press, erected in Woolwich dockyard, for bending and preparing armour-plates took place on the 19th ult. The first test consisted of a trial of two 4½in. armour-plates, made hot, forming a thickness of 9in. of solid iron, which were placed in the press and bent to a curve of seven-eights in the breadth of the plates in less than five minutes, at a pressure of 1000 tons on the whole surface of the piston, the pump making about 130 revolutions per minute. In the second trial the plates were adjusted so as to bring the pressure near the centre of the plate. The pump was then worked up to about 1539 tons by indicator, bending the two slabs of iron to a curve of one half in their breadths. The third and last trial consisted of a simple test of the working of the pump and the strength of the press. The pump worked up to about 1600 tons and exhibited no visible signs of weakness. The press is fitted with an improved apparatus—namely, a table or guide at the top of the cylinder to keep it from rising or canting, which will enable it to be worked up to the enormous pressure of 2000 tons. The Russian Government have desired Messrs. Westwood and Co. to supply three of these presses with the utmost possible despatch, after having investigated the capabilities of the press by a careful inspection during its erection in Woolwich dockyard.

ANTI-FOULING COMPOSITIONS FOR IRON SHIPS.—The difficult problem of discovering a mode through which the bottoms of iron ships shall be entirely preserved from fouling has been but little advanced by the experiment lately completed at Devonport. The premium offered by the Lords of the Admiralty for producing the long-desired preventives continues, therefore, open to competition. The iron-screw steam tender *Minx*, of 303 tons, which has engines of 10-horse power, commanded by Mr. James Pook, does harbour service for the Channel fleet, and supplies the ships with water. She received last September on her port side amidships three samples of different compositions, each 10ft. wide, and extending down to the bottom of the keel. The sample forward was that manufactured by Mr. Fidemore, the next was that supplied by Mr. Elsworth, and the third was a preparation recommended by Mr. Edwards, assistant-master shipwright in Devonport dockyard. The remainder of the port side forward and aft, and all the starboard side, received the composition of Mr. Hay, chemist, of Portsmouth. So prepared, the *Minx* was floated on the 10th of October, 1862, since which time she has been constantly occupied on harbour duty. Ships so employed foul much more speedily than those making long voyages. After three or four months' experience, it was found that sea-weed and grass had grown considerably on the port side of the *Minx*, which made her very "unhandy with her helm." Recently she was placed high and dry in dock, and an opportunity was given for examining her bottom minutely. There is considerable difference between her draught when laden with water, provisions, &c., as a tender, and when in ballast; and as she had been mostly in one or other of these conditions during the last seven months, the load line and the ballast or light line are marked most distinctly all round. Between the two there is not much vegetation, but on the lower line, where the compositions of Messrs. Finemore and Elsworth are laid on, there is a distinct fringe of weed two feet long. Below the fringe in the former, light sea grass, small barnacles, and much rust prevail. On Elsworth's composition there are barnacles and thick grass, but very little rust. On Hay's composition there are some weeds, many small barnacles, but very little rust. Before this preparation was laid on a coat of bitumen was applied to the iron. The test applied to the *Minx*, according to the present trial, places Mr. Hay's composition first, Mr. Elsworth's second, and Mr. Finemore's third, in order or success.

MESSRS. GWYNNE AND CO. have, we understand, received orders from the Admiralty for the supply of the pumping engines for the new docks at Malta (their patent centrifugal pump is to be used), and of a capacity capable of discharging 25,000 tons of water in four hours. Messrs. Gwynne and Co. have also in hand a pair of engines, with the centrifugal pumps for the dry-dock of Messrs. Palmer Bros., ship-builders, Newcastle-on-Tyne, and one to discharge 240,000 cubic feet of water in three hours, for the new floating dock for the Dutch Government now being constructed in Holland, &c.

PETROLEUM.—Messrs. Booth and Garrett, professors at Philadelphia U.S., have found that 2·599 gallons of petroleum oil produce as much light as 1000 cubic feet of coal gas, or 11·699 gallons of a mixture of turpentine and alcohol. For the price of the petroleum as compared to other lighting substances, the following return was made:—

	£	s.	d.
A quantity of light produced by spermaceti candles, cost	4	3	4
” ” by adamantine	2	11	5½
” ” by paraffin oil	2	8	8
” ” by coal gas	0	8	9
” ” by petroleum		4	5½

Owing to the cheapness of the petroleum oil, it is at present also employed as fuel in America. Thus an oil refiner of Erie uses it in place of coal, by leading it in the required quantity to the furnaces through a tube. By this means he realises an economy of £4 per week. As soon as means will have been found of removing the unpleasant smell petroleum spreads during the combustion, its use will become infinitely more extensive.

AN INTERNATIONAL EXHIBITION OF AGRICULTURAL MACHINERY will be held at Koenigsberg, Prussia, from the 24th to the 39th of August, 1863, in connection with the agricultural and horticultural gathering, intended exclusively for Prussia. Manufacturers of all countries are admitted to competition. The awards will consist of medals and diplomas. Several of the exhibited machines will be raffled for at the close of the exhibition. Most of the German railway companies have granted a reduction in the rates for transport of machines to be sent to the exhibition. Forms (which must be filled up and sent in before the 15th of June), and information may be obtained from the Secretary General.

AN INVENTION IN PHOTOGRAPHY has been made in Berlin. From the experiments of Herr Heckert, it will be possible henceforth, it is said, to burn photograph into glass. Herr Toelken, the secretary of the Royal Academy of Arts, speaks in high terms of the delicacy of the shades and the wonderful effect of light on a drawing of photograph correctness and abundance of detail. The first production of the new art will probably consist in transparent pictures, to be hung up against the window panes.

THE ALKALI WORKS REGULATION BILL.—The bill introduced by Lord Derby has been read a third time in the House of Lords. The title and provisions of the bill may be shortly stated as follows:—It is to be cited as the "Alkali Act, 1863." It is to come into operation on January 1, 1864. The term "alkali work" is to mean *every work in which muriatic acid is evolved*. Every alkali work is to be carried on so as to ensure, to the satisfaction of the inspector, the condensation of not less than ninety-five per cent. of the muriatic acid evolved. Any less condensation than this will make the owner liable to a penalty of fifty pounds for a first offence, and for every subsequent offence to a penalty not exceeding twenty pounds, nor less than two pounds, for every day the offence continues. All alkali works must be registered, and every change of ownership must be registered. The Board of Trade is to appoint inspectors to assigned districts. The next clause is important, as showing the wish of Lord Derby to ensure fairness in carrying out the Act. No land agent, nor any one engaged in any manufacture, or interested in any patent in or according to which the decomposition of salt or the condensation of muriatic acid may be effected, shall act as inspector under this Act. The inspectors may enter works at all reasonable times, day and night, without giving notice, but so as not to interrupt the process of the manufacture, to see that the provisions of the Act are carried out. The owners of the works, upon demand, are to supply the inspector with plans of those parts of the works (to be kept secret by the inspector) in which the salt is decomposed and the muriatic acid condensed. The inspector may make any experiments to ascertain the efficiency of the condensing apparatus, and the owner of the works is to give him all necessary facilities for the testing. All persons obstructing an inspector or refusing to give him the facilities incurs a penalty of £10 for every offence. The inspectors are to report to Parliament every year. Owners of works may, with the sanction of the Board of Trade, make special rules for the workmen attending to the condensing apparatus, and may annex penalties to the violation of such rules. The remainder of the Act refers to the recovery of penalties.

IMPROVED BORING MACHINERY.—The improvements which form the subject of the invention for which provisional protection has been granted to Mr. James Gilchrist, of Glasgow, have been designed with a view to obtain a more simple, convenient, and efficient arrangement of the parts than has hitherto been adopted. In one modification of the improved engine, the principal parts are fitted upon a framing, which is by preference mounted upon wheels. The parts comprise a steam boiler, winding details with actuating cylinder or cylinders, and a cylinder for imparting the required reciprocating motion to the boring rods; this last mentioned cylinder, which may be fixed or oscillating, is disposed horizontally, and its piston-rod actuates the vertical arm of a bell crank lever centred on a fulcrum, or on journals at a higher level than that of the cylinder, and having its other arm projecting horizontally outwards over the bore, and being connected to the boring-rods. The steam may have access to both sides of the piston, its action on both sides, or on one side only, being regulated by a suitable valve, actuated by hand or by the movement of the piston-rod itself; or the steam may be allowed access to only one side of the piston. The arms of the bell-crank lever need not in all cases be at right angles to each other, but may in some cases be arranged to suit a diagonal or inclined position of the actuating steam cylinder. When the boring-rods have to be drawn out of the bore, the bell-crank lever may be disconnected and turned out of the way.

PETROLEUM.—The importance of the trade in petroleum, or American oil, continues to increase at an unprecedented rate. The importations into Liverpool this year are stated in a circular of Mr. Macrae to have been more than 70,000 casks, against 8000 casks in the corresponding period of 1862, yielding in dock and town dues alone nearly £2000 for the four months.

JADE.—At the last sitting of the French Academy of Sciences, M. Damour described certain differences which existed between green and white jade, a well-known mineral which is brought over from Asia, under the form of vases, bracelets, hilts of daggers, &c., and which, according to our author, is a kind of tremolite. These two species of jade differ considerably from each other; the density of the white species being only 2·97, that of the green sort, 3·34; the latter is rather harder, a little more translucid, and of a slightly crystalline structure; its fracture is splintery, finely lamellary, and at times somewhat fibrous. Under the action of the blow-pipe it melts into a transparent glass, while white jade, on the contrary, is transformed into a dull white enamel. Both kinds resist the action of the nitric, hydrochloric, and sulphuric acids. A chemical analysis further shows that white jade is essentially formed of silica, lime, and magnesia, and therefore belongs to the family of the Amphiboles, while green jade belongs to that of the Wernerites, and the species called Dipyre.

NAVAL ENGINEERING.

THE IRON-CLAD FLEET.—A return has been issued, giving the names, tonnage, horse power, number of guns, dimensions, and other particulars of our iron-clads, with the dates when they were, or are expected to be, launched. Exclusive of the floating batteries, there are twenty-one iron clad vessels, eleven of which are building and will be launched as follows:—The *Valiant*, June, 1863; *Minotaur*, July, 1863; *Royal Alfred* and *Research*, August, 1863; *Prince Albert*, *Zealous*, *Royal Sovereign*, and *Achilles*, September, 1863; *Favourite*, January, 1864; *Agincourt*, March, 1864; and *Northumberland*, May, 1864. The ten launched are the *Black Prince*, *Warrior*, *Hector*, *Defence*, *Resistance*, *Caledonia*, *Ocean*, *Prince Consort*, *Royal Oak*, and *Enterprise*. The total tonnage of these vessels is 84,697, the number of guns carried 534, and horse power 18,060. Two of those building—the *Prince Albert* (2,529 tons, 5 guns, and 500 horse power), the *Royal Sovereign* (3963 tons, 5 guns, and 800-power)—are fitted with turrets on Captain Coles' principle; and three—the *Favourite* (2186 tons, 8 guns, and 400-horse power), the *Research* (1253 tons, 4 guns, and 200-horse power), and the *Enterprise* (990 tons, 4 guns, and 160-horse power)—are fitted with the turret on Mr. Reed's principle. There are seven floating batteries, carrying 106 guns.

THE TRIAL OF THE "BLACK PRINCE," 40, iron screw frigate, engined by Messrs. Penn and Son, took place at Portsmouth on the 22nd ult. Six runs were made with full boiler power at the measured mile, the mean speed of the six runs being 13·591 knots. The revolutions of the engines were, maximum, 54½, and the mean 53½. The load on the safety valve was 25lb., and the indicated horse-power 5300. The draught of water was 26ft. forward, and 27ft. aft. The propeller was a Griffiths of 24ft. diameter, 28ft. 6in. pitch, and 4ft. 10in. length. Two runs were made at half boiler power—six boilers, the mean speed of which was 12·221 knots, the revolutions of the engines being 47. The trials of steam having been concluded, the ship was next tried in making circles under full steam. With a starboard helm the full circle was made in 10 min. 3 sec., the half circle in 5 min. 20 sec., the angle of the rudder being 18 degrees, with two turns of the wheel, and the revolutions of the engines 48, having been 54 previously to commencing the circle. With a port helm the full circle was made in 10 min. 25 sec., the half in 5 min. 32 sec.; the angle of the rudder was 22½ degrees, the turn of the wheel 2½; and the revolutions of the engines 48. There were in both instances 12 men at the wheel. The speed attained by the ship was about one-tenth of a knot less than on her last trial. The time occupied in making the circles exceeds the average of our ships of war. She is steered by a screw over her rudder-head, but the lever arms of the screw are so confined in the rudder-head that the greater the angle is made with the rudder the less the power of the steering screw becomes.

THE "EMERALD," 34, screw frigate, Capt. A. Cumming, on the 8th ult. made her fourth experimental screw trial, at the measured mile in Stokes Bay, near Portsmouth. The ship's draught of water was, as nearly as possible, the same as on the three former occasions, being 20ft. 9in. forward, and 21ft. 10in. aft. The wind was at a force of from 2 to 3 from the south-east. The screw used on this occasion was one of four blades, the blades being set at equidistant intervals round a Griffiths boss. The mean of six runs made gave the ship a speed of exactly 12 knots, an extremely satisfactory result, and fully confirming those obtained with the same description of screws in the experimental trials of her Majesty's ship *Shannon*. In fact, it may be stated, that the four trials of the *Emerald* confirm the trials made with similar screws in the *Shannon*, and that so far nothing has been added to the knowledge we already possessed on the subject. It is expected, however, that the *Emerald* will conclude her series of trials with the leading corners cut off her four and six-bladed common screws, and with a two, a three, and a four-bladed screw of the Griffiths pattern. In making the circles on this occasion at the conclusion of the six runs at the measured mile, the *Emerald*, with the helm aport, made the circle in 7 min. and 9 sec., the angle of the rudder being 13½ deg., and revolutions of the engines 53. With the helm a-starboard, a full circle was completed in 8 min. and 22 sec., the angle of the rudder being 14 deg., and the revolutions of the engines 53½.

THE "CURACOA," screw frigate, made her official trial of speed on the 18th ult., at the measured mile in Stoke's Bay. Six runs were made at the mile with full boiler power, the mean speed of the ship being 10·750 knots. Four runs at half-boiler power gave the ship a mean speed of 8·670 knots. Circles were also made with the following results:—With full power:—Port helm—The half circle was made in 3min. 31sec. and the full circle in 6min. 46sec., the angle of rudder being 15 deg., the turns of wheel 2½, and the revolutions of engines 69½. Starboard helm—The half circle was made in 3min. 8sec., and the full circle in 6min. 15sec., the angle of rudder being 15 degrees, the turns of wheel, and the revolutions of engines, 68. With half power:—Port helm—The half circle was made in 4 min. 7 sec.; the full circle in 8 min. 22 sec., the angle of rudder being 19½ degrees, and the revolutions of engines 51. With half power:—Starboard helm—The half circle was made in 3 min. 52 sec., and the full circle in 7 min. 29 sec., the angle of rudder being 19½ degrees, and the revolutions of engines 51. The machinery, 350-horse power, by Maudslay, Field and Son, gave every satisfaction to the officials on board by its working.

PLATED FRIGATES FOR TURKEY.—Mr. Tucker, one of the superior officers of the shipwright's department of Woolwich Dockyard, has been ordered by the Board of Admiralty to proceed to Glasgow and survey the frigates (three in number) under construction by Messrs. Napier and Co. for the Turkish Government. The frigates will be built of iron, of the *Warrior* class. Two of the number are alreaday somewhat advanced.

VENTILATION OF THE IRON-CLADS.—In consequence of the great success which has attended the newly-invented ventilating arrangements on board the iron-clad screw frigate *Royal Oak*, 35, Capt. Campbell, fitting for sea at Chatham, the Lords of the Admiralty have decided on introducing a similar system on board the other vessels composing the squadron of armour-plated steamers. Orders have accordingly been received at Chatham dockyard for one of the officials from Devonport dockyard to proceed to Chatham for the purpose of obtaining a knowledge of what has been done, with a view to their being applied to the armour-plated frigate *Ocean*, recently launched at Devonport. The system of ventilation carried out in the *Royal Oak* is from a plan submitted to the Admiralty by Capt. Fanshawe, superintendent of Chatham dockyard; the engine-room and stokeholes being ventilated according to the principles laid down by Mr. Baker, inspector of machinery, and the chief of the engineering department at Chatham.

A NEWLY-INVENTED ELECTRO MACHINE COATING is about to be applied to the plates of the iron-cased steam-frigates *Gloire* and *Invincible*. It appears that this new composition has been found to be very successful in the preservation of metals. The Minister of Marine has addressed a despatch to the several Port Admirals, instructing them to send a number of shipwrights to Paris, to be instructed in the preparation of this new composition.

NAVAL APPOINTMENTS.—The following appointments have taken place since our last, J. Roberts (a), Acting Chief Engineer; F. H. Herring, Engineer, J. Ambler and T. Carline, First-class Assist. Engineers, and W. Scott, E. J. Humphreys, and T. W. H. Ramsey Acting Assist. Engineers, to the *Orontes*; W. C. Heck, Engineer, to the *Cambridge*, for the *Redwing*; J. Blight, acting Engineer, to the *Indus* for the *Gleaner*; J. A. Tuck, Chief Engineer, J. Hill, Engineer, P. Richmond, acting Engineer, A. Martell, J. Clark and H. Darroll, acting Engineers, and H. W. Ross, and W. Ambler, acting Assist. Engineer, to the *Royal Oak*; E. F. Lucas, acting Assist. Engineer; to the *Asia*, as Supernumerary; R. Williams, Chief Engineer, W. W. Christie, Engineer, and C. R. Lacy, H. J. Wilson, J. Forrest, H. London, and W. Hallowell, Assist. Engineer, to the *Liverpool*; H. C. Jones, Engineer to the *Fisgard*, for the *Enterprise*; W. Inglis (b), First-class Assist. Engineer to the *Pantaloon*; C. H. Henley, Second-class Assist. Engineer, to the *Black Prince*; G. Rigby, Supernumerary in the *Indus*, promoted to First-class Assist. Engineer; A. M'Innes, Chief Engineer, to the *Geyser*; J. Ross, Engineer, to the *Indus*, for hospital treatment; J. Wyllie, and A. Moreton, Assist. Engineers to the *Valorous*; H. A. Henri, and G. Thompson, Engineers, to the *Indus*, for the *Tilbury* and *Nightingale* respectively; F. Day, Assist. Engineer, to the *Fisgard*, as supernumerary; J. Smethers, of the *Jackall*, J. F. Hattersday, of the *Edgar*, W. M'Glashan, of the *Electo*, P. Thompson, of the *Pembroke*, Williams, of the *Rhadamanthus*, and T. W. Cameron, of the *Princess Charlotte* promoted to be First-class Assist. Engineers; T. Marsh, of the *Orlando*, R. L. Owen, of the *Charybdis*, H. J. Packer, of the *Algerine*, M. Blunk, of the *Bacchante*, C. Wiggins, of the *Coromandel*, and J. H. Scarlett, of the *Encounter*, promoted to be acting First-class Assist. Engineers; J. Melrose, Assist. Engineer, to the *Mirror*; F. G. Gissing, in the *Asia* for the *Foam*, promoted to Engineer; T. W. Bower, Engineer, to the Ajax; J. Annable and J. Roberts (B), Assist. Engineers to the *Indus*, as Supernumeraries; H. J. Hall, Acting Second-class Assist. Engineer to the *Indus*; P. Butler, H. Wooley, and C. J. Incher, Engineers, to the *Columbine*, *Alert*, and *Leander* respectively; J. C. Gravand, and J. J. Rose, Assist. Engineers, to the *Columbine*; C. C. Hyde, and K. M'Caskill, Assist. Engineer, to the *Alert*; R. Bacon, Engineer, and E. Watson, Assist. Engineer to the *Geyser*; R. S. Lee, Assist. Engineer to the *Marlborough*; P. Colquhoun and J. Green, Acting Second-class Engineers to the *Orland*; W. H. Steil, Acting Chief Engineer, T. S. Grice First-class Assist. Engineer, and H. White (B) Acting Second-class Assist. Engineer

to the *Cossack*; E. J. Murphy, First-class Assist. Engineer to the *Edinburgh*; J. A. Cooke Acting Second-class Assist. Engineer to the *Fire Queen*; J. Ward Chief Engineer, D. A. Campbell First-class Assist. Engineer, W. Harwood Acting First-class Assist. Engineer, and T. J. Andrewortha, Acting Second-class Assist. Engineer to the *Esk*; G. Weeks Chief Engineer to the *Majestic*; E. Daniels Engineer to the *Cumberland* from the *Salamis*; E. Judge First class Assist. Engineer, and F. Smiley Second-class Assist. Engineer to the *Cockatrice* R. H. Trubshaw Acting First-class Assist. Engineer, additional to the *Cumberland*, for the *Louisa*; D. B. Keiller Second-class Assist. Engineer to the *Caracoa*; R. Sutherland Second-class Assist. Engineer to the *Miranda*.

MILITARY ENGINEERING

Experiments at Shoeburyness.—These experiments took place on the 27th of April last. The target fired at was constructed at the Millwall Ironworks from the designs of Mr. Chalmers. The target was 13 feet long by 10 feet broad, faced externally with hammered armour-plates 3¾in. thick. Behind these were laid longitudinal teak beams 10in. wide by about 5in. deep, a web or flange of wrought-iron ⅝in. in thickness passing between each beam, and being rivetted to a plate 1½in. in thickness at the back. Behind this plate again came another pad of teak 5in. thick, which rested against the skin of the ship—the same thickness as that of all our ironclads, ⅝ths of an inch, and behind this were the usual upright beams or iron ribs of the vessel. Thus it will be seen that, though the target was apparently a light one from its external plates being only 3¾in. thick, yet in reality it had, after all, 5in. of iron in it, with 15in. of teak, exclusive of the longitudinal cellular iron webbing we have mentioned between the teak beams, which, though not nominally called upon to resist the shot, yet, in truth, aided the resistance enormously, by distributing the force of the concussion and giving great stiffness to the whole structure. The trial to which this target was subjected was precisely similar to that heavy ordeal which the *Warrior* target had to go through on the occasion of its *début* at Shoeburyness. The number of rounds fired, the guns, charges, and missiles were precisely the same on both occasions; but, as the target of Mr. Chalmers was nearly one-third smaller than that of the *Warrior*, the experiment was obviously more severe for the smaller target, as the fire had to be more concentrated The trials were gradually progressive in their attacking force from low charges, and shells filled with sand, up to solid 68-pounders, fired with the full service charges; 200-pounder solid cast-iron shot fired with low charges, then fired in salvoes of three at a time; and, lastly, simultaneous salvoes of three 110-pounders and two 68-pounders fired with full charges and solid shot. The live shell and shell filled with sand, as usual, effected very little, nor did the 110-pounder with 10lb. charge, nor the 200-pounder with a 10lb. charge do much more. The lower armour-plate of the three which composed the target was decidedly inferior to the two upper ones, and cracked badly early in the day. The method of fastening on the plates by 2½in bolts, with stopped conical heads and a square thread, contrary to general expectation, seemed to work admirably. Partly from the resistance offered by these bolts, and partly from the force of the concussion itself being so deadened and distributed, there was very little buckling out of the ends of the plates when struck even by the heaviest missiles. The dints in the armour plates made by the shot varied according to the weight of the projectile when rifled, and in no case were much to speak of. The 68-pounders, as usual, left a severe mark, in some instances nearly three inches deep. The salvoes of the two 68-pounders and three 110's were a severe trial. The five shots were concentrated on one spot, and struck with a terrific crash, splintering themselves to fragments. The main side of the backing—the skin of the ship, in fact—had, up to this time, been carefully examined after each discharge; for on the integrity of that under any fire depended, in fact, the success of the construction of the target. It had, however, shown no sign of yielding. Some three or four of the small rivet-heads had been jumped off, with one or two small bolts, and there was a just perceptible deflection of one or two ribs where great strains had come, but this was all. The armour-bolts all held firm, and the back of the target showed no sign that it had ever been fired at. One of the armour bolts was struck and the head knocked off at the back, and the ribs gave tokens of distress, but beyond this it was perfectly astonishing to see how well the target withstood the five ponderous missiles. The worst and most dangerous parts of the programme had been borne by the target with impunity, and, as it was wished to see how the backing would break, if it could be broken, Mr. Chalmers was asked to permit the 300-pounder rifled Armstrong, loaded with its formidable steel shot, to be used against it. The 300-pounder was accordingly loaded with a 45lb. charge, and sent its projectile completely through the target, leaving a large and ragged hole, though not so ragged as the same shot would have made in passing through armour plates backed up by teak in the common fashion. This destructive shot brought the experiments to a close, the result of them being undoubtedly in favour of Mr. Chalmers's system of backing the plates, which is much superior to the plans adopted either with the *Warrior* class of vessels built, or the *Minotaur* class now building.

Testing Armour Plates at Portsmouth.—A testing of armour plates on the *Powerful*, old sailing line-of-battle ship took place on the 21st ult. The plates tested comprised one rolled, from Messrs. John Brown and Co., Sheffield, 15ft. in length, 3ft. 8in. in width, and 5in. in thickness. The Thames Ironworks sent two hammered plates of about the same dimensions as Messrs. Brown's The Mersey Works, Messrs. Clay and Horsfall's sent two hammered experimental charcoal-iron plates of about 5ft. by 3ft. 3in., and 5in. in thickness; and the Millwall Ironworks sent three of nearly the same dimensions, two of the three being rolled iron, and the third of steel. The practice was made as usual, under the superintendence of Capt. R. S. Hewlett, C.B., with a 95cwt. 68-pounder gun, and the distance was 200 yards. Messrs. Brown's plate received nine shot in one third of its length. One of the Millwall iron plates received eight shots, and the other seven. One of the Thames plates received eight shots, three overlapping each other, and four others being edge blows. All these plates were more severely tested than was the 5½-inch French plate that was recently tried at Portsmouth, and all passed the tests with considerably less injury to the metal than was inflicted on that plate. The second plate of the Thames Company was not of quite so good a quality as the first named, and the experimental steel plate of the Millwall Company broke up under the first shot. The two plates manufactured by the Mersey Company were also easily broken up by the shot. It is necessary to state with regard to these two plates that the Mersey Company manufactured them at the request of a company in the iron trade, having a peculiar kind of charcoal iron, which they thought very suitable for armour plates, and which they desired to be tested. The result has, however, proved it to be utterly unfit for the purpose.

A Miniature Breech-loading Cannon upon a new principle, the invention of Mr. L. W. Broadwell, of New Orleans, U.S., was proved on the 22nd ult. at the experimental ordnance range at Woolwich, in the presence of the Select Committee of Woolwich Arsenal, and gave satisfactory results. The chief recommendations of the new gun are the remarkable simplicity of its breech-loading arrangements, and the solid and substantial method on which it appears to be constructed, as proved by its resistance of the severe test to which it was subjected on trial. The gun is on a small scale, for experiments only, and when brought out on larger dimensions will, as stated, prove a most serviceable weapon. No training is required to initiate the gunner, the method of loading being simply the removal and replacing of a small block of iron for the introduction of the charge. There is a self-acting expanding ring, which serves to seal the breech hermetically at the moment of discharge, and which does not impede the movement of the vent-piece. The projectile invented by Mr. Broadwell to be used with the gun is an elongated shot, and is simple and plain in construction.

STEAM SHIPPING.

Trial of an Anglo-Chinese Despatch Boat.—A very interesting trial took place on the 6th ult. at the measured mile in Stokes Bay, near Portsmouth, of the new paddle-wheel steamship *Kiang-Soo*, built by Mr. John White, of West Cowes, for the Emperor of China. This vessel is built on a diagonal principle. Her length is 241ft., breadth, 29ft.; depth, 15ft. 3in.; and tonnage, builders' measurement, 1000 tons. She is fitted with oscillating engines, constructed by Messrs. C. A. Day and Co., of the Northam Ironworks at Southampton, and has patent feathering paddlewheels. The diameter of the cylinders is 68in., with 5ft. stroke, and the velocity of the piston at full power 450ft. per minute. The *Kiang-Soo* left the Southampton Docks, where she received her engines and machinery on board, and steamed rapidly to Stokes Bay, where she was at once placed on the mile, and the result of four runs was as under:—First run, 3 min. 59 sec., equal to 15·063 knots per hour; second run, 3 min. 8 sec., equal to 19·149 knots; third run, 4 mins. 4 sec., equal to 14·754 knots; fourth run, 3 mins. 15 sec., equal to 18·462 knots; the Admiralty mean of the whole being 16·903 knots, or 19½ statute miles per hour. Revolutions of engines, 45; pressure of steam, 27lb.; vacuum, 26in. The engines, which are of 300 nominal horse power, worked up to 2,279, being over 7½ times their nominal power. The vessels mean draught of water was 9ft. 3in. At her highest rate of speed there was scarce any perceptible vibration, the machinery working with the greatest freedom, and she steered very easily. The boilers gave out an unlimited quantity of steam during the day. After the four runs were completed the vessels head was put to the eastward, and she ran rapidly through Cowes Roads, down the Solent, to the Needles, subsequently returning to Stokes Bay for a trial of her speed at half power. With only two boilers at work she traversed the mile in 4 min., or 15 knots per hour, and a second time in 4 min. 27 sec. or 13·483 knots, the mean of the two being 14·241 knots per hour, with the exercise of only half her steaming power; revolutions, 33; steam, 20lb.; vacuum, 27in. With such extraordinary results as these, the *Kiang-Soo* was unanimously pronounced by all the naval and scientific authorities present to be one of the fastest vessels afloat. The *Kiang-Soo* is intended as a despatch-boat for the Chinese navy, for the special personal use of Captain Sherard Osborne, the commander-in-chief of the Anglo-Chinese expedition.

The "Brighton," paddle-wheel steamer, belonging to the Weymouth and Channel Islands Company, having had new boilers and superheating apparatus fitted to her, underwent a trial at the measured mile, at Stokes Bay, on the 8th ult., when her speed was found to average 13 knots, or 15 statute miles per hour. The trial was pronounced in every way satisfactory.

The Esploratore.—On the second trial of the Royal Italian despatch vessel *Esploratore*, built by Messrs. Wigram, and fitted with engines of 350-horse power by Messrs. John Penn and Son, which took place recently, the speed was greater than on the former occasion. It was 17·26 knots, a gain of rather more than a quarter of a knot, or 20 statute miles per hour. The engines worked up to seven times their nominal horse power. With less than half the power of the Holyhead boats the *Esploratore* attained a greater speed.

Steamship Building on the Clyde.—Messrs. Tod and M'Gregor have entered into a contract to build a screw of 3000 tons for the British and North American Royal Mail Steam Navigation Company. The vessel, which will rank with the *Scotia*, *Persia*, &c., is to be named the *Cuba*. The *Artibonite*, just completed by Mr. Seath, for the Société Accélérée d'Haiti, has made a trial trip at the measured mile on the Gareloch. She is of 250 tons register, with engines of 50-horse power, capable of working up to 150-horse power effective; and at her trial she attained a mean speed of 11 miles per hour, being one mile above the rate specified in the contract, although the up runs were made against a gale of wind with the screw only partly immersed. Messrs. Scott and Co., of Cartsdyke, have launched a screw of 530 tons, named the *Vartry*, now being fitted with engines of 80-horse power by the Greenock Foundry Company. She has been designed specially for the transport of machinery and heavy castings.

LAUNCHES OF STEAMERS.

Launch of an Iron-cased Battery for the Russian Government.—The launch of the Russian iron-cased battery *Pervenetz* took pace on the 18th ult., at the Thames Ironworks and Shipbuilding Yard, Blackwall. The *Pervenetz* is a remarkable iron-cased ship, of the following dimensions and tonnage:—The length between perpendiculars is 220ft.; the length of keel for tonnage, 188ft.; the breadth for tonnage, 53ft.; the depth of hold, 26ft.; and the burden, 2811 tons. In other words the length of the *Pervenetz* is only equal to four times the breadth; while our *Monitaurs* and *Warriors* are in length something like seven times her breadth. This is one of the points that distinguish the *Pervenetz* from the iron-cased ships we are constructing and converting. Another equally important point is, that the sides of the *Pervenetz* are inclined at an angle of 27 degrees from the vertical; and the stem and stern, instead of projecting, as usual, above the load water-line, recede so as to relieve the ship from all possible top hammer at the extremities. Above the water, therefore, the *Pervenetz* is a ship constructed on the Jones' angulated principle, and not only are the sides angulated, but so are the extremities fore and aft. In such a structure there is considerable unsightliness at launching, but it will entirely disappear with the immersion consequent on completing the armour plating, the rigging, and the shipping of the armament and service stores. There is great displacement, light draft of water, top hamper reduced to a minimum by the sloping sides, and fore and aft fire. from the bow and stern, on a line with the keel. The engines, by Messrs. Maudslay, Sons, and Field, are of 300-horse power, capable of being worked to 500-horse power, so as, under favourable circumstances, to secure a speed of 9 to 10 knots an hour, or from 11 to 12 statutes miles. The armament on the main deck will consist of 28 68-pounders, or guns of greater calibre should such be desired; and on the upper deck there will be mounted four large pivot guns, We have given at another page illustrations and further descriptive particulars relative to this vessel.

Launch of an Iron-clad for Denmark.—The *Rolf Krake*, a cupola screw armour-clad man-of-war, built for the Danish navy, was recently launched from the building-yard of Messrs. R. Napier and Sons, on the Clyde. Her dimensions are—length over all 185ft.; breadth, 38ft.; depth, 14½ft.; engines, 240-horse power; tonnage, 1,246 tons. She is completely armour-clad from stem to stern, the plates extending for some distance below the water line. Her armour plates are 4½in. in thickness, increasing to 7½in. at the port-holes, with a backing throughout the hull of 9in. of teak. The cupolas or towers are built of plates outside, fixed on T-iron, and backed by 19in. of teak, the plates being 4½in. thick. These cupolas project 4½ft. above the upper deck, and are 21½ft. in diameter. They revolve on the lower deck, on which the gearing rests, and where they are easily turned either from the inside or from the outside. Her armament will consist of four 68-pounder guns, two in each tower, being worked inside and pointed by a gunner, who will take aim from a manhole in the grated roof. The same principle to ensure great strength has been carried out in building the *Rolf Krake* as in the *Black Prince* and *Hector*.

Launch of the "Salamis."—This vessel, designed by the master shipwright at Chatham, Oliver W. Lang, Esq., was successfully launched from Chatham Dockyard, on the 19th ult. The *Salamis* was laid down August 10, 1861; she is built upon the diagonal system, the wood used being mahogany, and it is calculated she will be one of the fastest steamers in the Royal Navy. Her principal dimensions are—Length between perpen-

dicnlars, 228ft. over all; breadth, extreme, 28ft. 2in.; depth of hold, 14ft. 6in.; burden in tons, 834 50-94; horse-power, 250; she will carry two guns. The machinery is to be supplied by Messrs. Ravenhill, Salkeld, and Co. On the *Salamis* being brought up alongside the *Adder*, her draught of water was found to be forward, 4ft. 3in., and aft. 4ft. 6in.

The "Lord Gough" was launched from the yard of Messrs. Caird and Co., on the 2nd ult. She is the property of the Dublin and Glasgow Steam Packet Company. Her dimensions are:—Length, 230ft.; breadth, 26ft., and depth, 74ft. 9in. She will be propelled with oscillating engines of 350-horse power.

TELEGRAPHIC ENGINEERING.

Telegraphic Communication with Australia.—Two projects are in the field for connecting Australia with Java. It is proposed to lay the cable on the north-west of Australia, on the shores of the Gulf of Carpentaria, or to take it round to Brisbae, the capital of Queensland. At this point the cable would be in communication with the existing intercolonial lines; and New South Wales, Victoria and South Australia would be thus brought into connection with the countries of the old world. The cost of laying the line from Java to Queensland is estimated at £1,000,000, but from Java to the north-west a cable could be laid for £243,000. Considering the many risks to which the submarine cables are exposed, and the uncertainty of their action, there can scarcely be a doubt as to the policy of selecting the cheaper route. The cost of such a land line has been estimated at £120 per mile, or for the whole distance from the north-west coast to Adelaide a sum of £177,000, which would make together a sum of 420,000, as the cost of the complete system from Java to Adelaide.

RAILWAYS.

Paris, Lyons, and Mediterranean Railway.—It appears that in the course of 1868, the administration devoted to the traffic service 106 new locomotives with tenders, of which six only were for the transport of passengers, the remaining 100 being required for goods. The rolling-stock of the company was also increased last year by 104 passenger carriages, and 5611 goods trucks of various models, principally, however, coal trucks. The orders now in course of execution, and which will be carried on in whole or in part in 1863, are 111 locomotives and tenders, 190 passenger carriages, and 1700 goods trucks. A part of this plant is constructed in the company's own workshops at Ouillens. The traffic of this system is immense. The receipts are now close upon £130,000 per week, and there can be little doubt that the revenue for 1863 will approach, if indeed it does not exceed, a total of £6,500,000 In 1862, the receipts increased £400,000 as compared with 1861; and in 1861, they advanced £1,000,000, as compared with 1860.

The South Austrian and Lombardo-Venetian Railway.—This great work now includes 1482 miles, and 440 miles more are yet to be completed. The company carries on a foundry of its own at Gratz, and makes all its own rails and other heavy ironwork at a very reasonable cost. On the Venetian lines all that remains to be constructed are the station at Venice, the bridge over the Piava, and the line from Padua to Rovigo. The whole of the Lombard lines will be at work this year with the exception of the short piece from Gallaratta to Calendo, which will be completed in the spring of 1864. As to the Central Italian branch, the second section is to be opened in the course of the autumn, and the remainder in the autum of 1864. The total traffic receipts amounted for the year 1862 to £2,621,024; the expenses to £991,625, showing a surplus of £1,629,399, being an augmentation over the receipts of 1861 of £72,670. Adding the surplus to the balance from the preceding year and the interest on investments, the available sum will be £1,749,439, out of which the allowance for the sinking fund and interest on the loans must be deducted, leaving a balance equivalent to a dividend of 34s. per £20 share for the year 1862. The total capital received to the 31st of December last, amounts to £26,160,000; three-fourths of the company's lines have been opened for traffic; a dividend at the rate of 10 per cent. per annum, on the average has been distributed during the past four years among the shareholders, and the interest on loans has been paid out of the profits of working the open portions of the lines in course of construction; the profits on exchanges and the interests on investments, with the exception of about £800,000 which was, as usual, charged to capital, being only about 3 per cent. of the total expenditure on capital account.

Eastern of France Railway Company.—At the close of the year 1862, the rolling stock of this company comprised 614 locomotives of various systems, 501 ordinary tenders, 25 tenders on the Engorth principle, 1582 passenger carriages, 11 Imperial carriages, and 11,190 trucks of various descriptions. This stock was increased last year by the delivery of 313 additional goods trucks. The administration has ordered 21 locomotives, 12 tenders, and 84 trucks, which will be delivered in the course of the present year.

Improvements in Railways.—A new economic permanent way, designed by Mr. G. F. Griffin, is attracting attention. The sleepers are made of currugated cast-iron, and the cost per mile is stated at £1245 against £1806, or £1844, under the existing systems. Apart from saving in annual maintenance, Messrs. Brassey, Betts, Trevethick, and others have given very favourable opinions of its qualities, and an experimental portion laid down about 15 months ago on the Great Northern line is stated to have shown most satisfactory results.

New Railway in Russia.—It is understood that a new railway line, in connection with the Riga and Dunaberg lines, is about to be brought out, with a capital of £2,500,000.

New Railway Carriages in France.—A trial is being made on the Eastern Railway of some new carriages which will, it is expected, remedy many inconveniences long complained of. A passage in the centre communicating with one compartment to another enables the railway officials to see what is going on during the progress of the train, and allows the passengers to freely move about from one end of the carriage to the other. A platform or balcony for smokers is placed at one end. Ventilators are also fixed, which can be opened or shut at pleasure so as to give a supply of fresh air. The new plan appears to present the following advantages—security, facilities for smoking without annoyance to anyone, and exemption from danger of fire, as the carriage is constructed of sheet-iron.

Russian Railways.—It is now understood that a new Russian railway line, in connection with the Riga and Dunaburg, is about to be brought about, with a capital of £2,500,000.

The Bhore Ghaut Incline.—The construction of the Bhore Ghaut Incline, now completed, has occupied more than seven years, and during the greater part of that time there have been 45,000 workmen daily employed upon it. The incline is a series of tunnels through mountains of rock, and viaducts stretching across valleys, alternating with each other, each part a triumph of modern science and skill; the *ensemble*, stupendous in virtue of its magnitude and stability. Some of the grandest embankments have been raised up within the last few months—some, in fact very recently. These necessarily require heavy rains to settle and solidify them. As a matter of course they will sink many feet in the next rains. This will render the use of the incline impossible during the first monsoon. Until the rain actually fails, however, any amount of traffic may safely flow up and down the line, and after the approaching rains no serious interruptions, will occur on the incline. The measures of safety that have been adopted are such as to secure it, in so far as it possible for man to do so. The formal opening of the Incline by the Governor of Bombay took place on the 21st April, at Lanowlie, the top of the Incline. In The Artizan of October, we gave a copper-plate engraving of one of the powerful locomotives, specially designed by Mr. Kersnam, for working on the of the India Peninsular Railway. We also gave some further details and particulars as to the gradients, &c.

RAILWAY ACCIDENTS.

Accident on the South Western Railway.—On the 12th ult., a serious accident occurred between the Wilton and the Dinton Stations on the South Western Railway. The up luggage-train arrived at Dinton Station shortly before nine o'clock a.m., and was allowed to go on. The ordinary mixed train also left Salisbury at eight o'clock, and was despatched by the station-master of the Wilton Station. There is a double line of rails between Salisbury and Wilton, but from that point to Dinton it is single, the additional line not being completed. The consequence was that the two trains came violently into collision near Hurdcott. The speed of each train was very much diminished; but the two engines ran into each other. There was between thirty and forty passengers, and all were more or less injured.

BOILER EXPLOSIONS.

Manchester Association for the Prevention of Steam Boiler Explosions.—At the ordinary monthly meeting of this Association, held on April 28th, 1863, the chief engineer presented his monthly report, of which the following is an abstract:—"During the past month, there have been examined 288 engines and 406 boilers. Of the latter, 6 have been examined specially, 11 internally, 79 thoroughly, and 310 externally; in addition to which 2 of these boilers have been tested by hydraulic pressure. The following defects have been found in the boilers examined:—Fracture, 5 (1 dangerous); corrosion, 30 (1 dangerous); safety-valves out of order, 1; water gauges ditto, 8; pressure gauges ditto, 9; feed apparatus ditto, 1; blow-out taps ditto, 32; furnaces out of shape, 4; over-pressure, 4; blistered plates, 4—Total, 98 (2 dangerous). Boilers without glass water gauges, 6; without blow-out taps, 13; without back pressure valves, 21. Three explosions have occurred during the past month to boilers not under the inspection of this Association, by which nine persons were killed and four others injured. All of these explosions occurred so far from Manchester, that only one of them—viz., No. 8, which was by far the most important—has been personally investigated. No. 8 Explosion.—This explosion occurred at an ironworks, and is one of the most remarkable that have come under the notice of this Association—five boilers, working side by side, having in this instance exploded simultaneously, the shells of all of them being rent asunder, and thrown to a considerable distance from their original brickwork seating, which was completely destroyed, and reduced to an unintelligible heap of ruins. The fragments and boiler fittings were shot in every direction, many of them falling through the roofs of the adjoining buildings, and one through that of the dwelling-house of the proprietor. Two of the boilers were thrown over a tramway, and landed in a ploughed field beyond; one of them raking the rails in its course, cutting them completely through at the solid metal, and tearing up the roadway, a piece of one of the rails, that had been shorn off, being carried away to a distance with the boiler. There was a strong tendency to impute this explosion to the action of explosive gases, or to the instantaneous generation of steam, from red-hot plates; since it was thought, that steam of the ordinary working pressure was quite inadequate to produce the results developed. These views are always revived on the occurrence of every serious explosion; and although chimerical, still have an importance, though a most unfortunate one, from the fact, that they tend to divert attention from the simple cause of the disaster, while they throw an air of mystery around the subject, which at once arrests all sound investigation, and thus destroys the chance of one explosion becoming the means of preventing the occurrence of others. If, however, at any boiler explosion, the existence of an agent more subtle and destructive than steam ever appeared probable, it certainly was in the present instance. Still, a little investigation will show to how simple a cause the whole may be traced, and though great as was the havoc, there is no need for the supposition of any force beyond that of steam at an ordinary working pressure. To do this, it may be well to enter more into detail as to the general arrangement, construction, and fittings of the boilers, as well as into the position of the fractures, and flight of the parts. The five boilers were ranged side by side, all of them being connected, both by the steam-pipe and feed-pipe. Their direction was very nearly north and south, the furnaces being at the south end. No. 1 boiler, commencing at the west, was of Cornish construction and internally-fired, while the remaining four were cylindrical, with egg-ends, and externally-fired. The length of all the boilers was about 25 feet, while the diameter was 6 feet in No. 1, and 5 feet in the remaining four, the thickness of the plates being seven-sixteenths in the former, and three-eighths in the latter. The boilers were each fitted with one feed back-pressure valve, and feed stop-valve combined, one glass water guage, one alarm low-water steam whistle, worked by a float fixed inside the boiler, and one lever safety-valve, of 4 inches diameter, in addition to a Bourdon's pressure-gauge fixed on the steam-pipe at some distance from the boilers. The safety-valve admitted of a pressure of nearly 60 pounds per square inch, but it was stated that 45 pounds had been the limit at which the boilers had been worked, since the weight had always been placed at some distance from the end of the lever. Even the higher pressure, however, would not have been excessive for boilers of such dimensions, as far as the cylindrical shells are concerned. The rents were extremely complicated by the effects of the explosion, and although highly important to do so, it is in these cases difficult to determine which are the rents from which the explosion sprung, and which are those that resulted from it; or otherwise, which are the primary ones, and which the secondary. It appeared, however, that all the egg-ended boilers had rent in two, transversely, one portion flying northward and the other southward, the rent occurring at one of the transverse seams over the furnace, while the larger portion had in every instance flown northwards. In some cases both ends were blown out, and the plates 'vandyked,' and curled up, the distortion being such as is difficult to describe. The Cornish boiler was also rent transversely, at about the middle of its length, both through the shell and flue tube, the end furthest from the furnace being demolished, the shell being opened out, ripped spirally, and the end plate torn off. The other half of the boiler was comparatively uninjured, the whole, though thrown from its original seating, holding together, and the furnace retaining its cylindrical shape. All the transverse seams of externally-fired, egg-ended boilers, placed immediately over the furnace, are liable to fracture unawares, and frequent opportunity has been taken in previous reports to call attention to their treacherous character. There were circumstances, however, which rendered these seams specially liable to fail in the boilers under consideration. The boilers were about nine years old, and fed with sedimentary water. Repair to the plates over the furnaces had frequently been rendered necessary on account of the leakage at the seams, though a decided improvement had been found to result on the adoption of surface blowing out by means of a scum-pipe. Also the introduction of the feed was peculiarly trying to these seams, since it was brought down from the top of the boiler by a vertical bell-mouthed pipe, terminating within six inches only, of the plates immediately over the furnace, the effect of which would be, by the intermittent introduction of the water, to induce alternate expansion and contraction and thus strain the seams. This combination of circumstances is considered quite sufficient to account for the primary fracture of one of the boilers at the transverse seams over the furnace. The fracture of these transverse seams, though very frequently attributed to shortness of water, is quite independent of it, and is constantly found to take place where the supply is ample. In these externally-fired boilers the steam is generated on a concave surface, while in internally-fired ones it is generated on a convex one, and it would appear as if the steam could not escape so readily from the concave surface as from the convex, and thus, lingering longer in its position, keeps the water from contact with the plate, and leads to its being burnt. In the internally-fired boilers, the steam generated at the sides of the furnace tube renders the stratum of water in contact with with the plate lighter than the surrounding mass, and thus an ascending current is set up which passes over its surface. This removes the globules of steam as soon as they are

formed, and substitutes a fresh film of water to be evaporated. It will be seen that this action cannot take place upon the concave surface, and it is thought that this may account for the fact, that while instances of injury to the plates of internally-fired boilers, when fully supplied with water, are quite exceptional, they are, with externally-fired boilers, of very common occurrence. Some externally-fired boilers with a hot fire have been known to bulge very shortly after setting to work, the injury being quite independent of any accumulation of sediment, while the same plate has in some cases had to be renewed again and again, its condition affording indications of having been red-hot, although known to have always been covered with water. The fact, therefore, of these boilers having failed over the furnaces, even through overheating, cannot be accepted as an evidence of their having been neglected and allowed to run short of water. A strong impression, however, existed that such had been the case with one of the boilers, since the colour of the plates had, it was stated, been quite blue immediately after the explosion, though shortly removed by exposure to weather. It should not be overlooked however, that the mere fact of explosion may give this appearance from the shock on coming to the ground after the flight, and from the blows the boiler receives on its course. These are quite sufficient to remove, at all events in places, any protecting scale from the plates, and to lay bare their original surface, the effect of which is mistaken for that of fire. The Cornish boiler, which was the most likely to have suffered from any neglect of the supply of water, had evidently not been short, since the shape of the furnace crown, with its coat of scale was unaffected. There still remains to be explained the fact of the whole series of five boilers having exploded simultaneously. The percussive force of water, as an important element in producing the destructive effects in steam boiler explosions, has lately excited considerable attention, and is a subject of much interest. The view is as follows:—The temperature of water in a steam-boiler working at 50 pounds pressure, is 300°, which is 88° above the boiling point at atmospheric pressure. On the occurrence of a rent above the water-line, or the rending off of a steam dome, the blowing-off of the manhole cover, or the fracture of a steam-pipe, &c., the steam above the surface of the water would escape and remove the pressure from it. The 88° of free heat, with which the whole body of water is charged, over and above that necessary for maintaining it at the boiling point at atmospheric pressure, would instantly flash a considerable portion of it into steam, whiles the globules, not being generated at the surface merely, but throughout the whole mass, would blow up the water with considerable force, converting it into a projective, having a velocity equal to that due to the pressure. This would give it a destructive force far greater than that of the simple statical pressure of the steam; just as in the injector, the stream of water acquires a force of penetration, that renders it superior to the pressure of the steam that imparted it, and which enables it to enter a boiler working at a higher pressure, than the one supplying the injector. It is thought, by its advocates, that on this principle it is possible that an explosion might happen, without either the existence of any previous weakness of the boiler, the occurrence of any primary rent, or excessive pressure, but simply from the sudden removal of the steam from the surface of the water, when it would be violently projected, as just explained, against the upper part of the shell. It has been proposed to submit this to the test of experiment, and to accomplish the instantaneous clearance of the steam space, either by condensation, effected by the introduction of a jet of cold water, or by the opening of a large valve. Such an investigation would certainly be most interesting and useful, while the result would be highly prized by the engineering world. Of the fact of the sudden liberation of the steam throwing up the water there can be no question, since that is already a matter of experience; whether, however, the entire steam space can be so instantaneously cleared, as to allow a sufficient velocity of the water being attained,—on the accomplishment of which the force of impact depends,—appears to me a matter of question, and I cannot but think that steam would be generated with sufficient rapidity upon the surface of the water, to retard the velocity of the mass, as well to form a cushion which would soften the blow against the shell of boiler. This is a nice point, and must await the issue of the experiment for determination. I have for some time since, in examining exploded boilers, carefully searched for indications of this action, and it appeared at first that there were manifestations of it in the explosion under consideration. For instance, the feed water had been introduced, as previously stated, at the top of the boiler, the feed stop valve being bolted to the side of the steam dome, and the water carried by the feed-pipe through the steam space. The failure of this feed-pipe, would have allowed the water to play amongst the steam, and thus produce the very condensation desired in the proposed experiment just mentioned; added to which, the steam domes were torn off from the shells, as if by upward impact, and blown in a different direction to the boilers themselves. The feed water, however, proved to have been heated by the exhaust steam from the engine, and thus would have produced but tardy condensation: and even if the flight of one boiler, on the rending of the transverse seams over the furnace, had, carried away the steam-pipe or rent off the domes of the others, which is highly probable, and thus by suddenly relieving the steam pressure, set up this percussive action,—still, the force of the impact which must have been upward, can hardly be supposed to have developed the transverse rents previously described, or to have thrown one-half of the boiler to the south and the other to the north. With a full appreciation of the value of the impact theory, it is not thought that it applies in the present instance, as having produced primary rents, important as it may have been in developing secondary ones. The cause of the simultaneous explosion is thought to have been as follows;—A single externally-fired egg-ended boiler say No. 3, rent at one of the transverse seams over the furnace in the first instance. The escape of steam and water from the bottom of the boiler then lifted the remaining ones, and threw them up in the air several feet high, blowing down at the same time the brickwork seating, so that the boilers, on coming again to the ground, fell upon aloose irregular bed, and all became so strained that each rent and exploded in turn. That the percussive action of the steam was sufficient to have done this, as illustrated by the fact, that one of the cast-iron rolls from the mill, was lifted by it at the time of the explosion to a height of several feet. Explosions Nos. 7 and 9 were very similar in character one to the other. Neither of the exploded boilers having been personally examined, only the following scanty particulars have been obtained:—Explosion No. 7, occurred at a colliery to a cylindrical externally-fired boiler, 36ft. long and 5ft. in diameter. This boiler formed one of a series of five, being the second from the engine-house. It was sent by the explosion into four pieces, while the escape of the steam and water blew up the boiler seated next to it, which was the centre one of the series, flattening it on one side; reversing it end for end in position, and rolling it over the other boilers, finally depositing it on the ground beyond. It will be seen that the treatment of this boiler, on the rupture of the one alongside of it, corroborates the view given with regard to the cause of the simultaneous explosion of the five boilers referred to above, and it is hoped that fuller particulars may be obtained. No. 9 Explosion occurred at an ironworks, to a cylindrical externally-fired boiler, about 32ft. long and 5ft. in diameter, which was the outer boiler of a series of five. It will be observed that the seven boilers which have exploded during the month, have all been of the egg-ended externally-fired class, with the exception of the Cornish one, which suffered only, through the explosion of the others; and it is trusted that the fact of the constantly recurring failure of these externally-fired boilers will at length dispel the false estimate, so generally entertained, of their safety. The proprietor of the iron works at which No. 8 explosion occurred, at once adopted the wisest course, and resolved upon having no more of the externally-fired class upon his works, but laying down 'Lancashire' boilers in their place; experience having shown him, that the plates over a furnace of an internally-fired boiler, may fail without moving it off its seat, or causing any loss of life; while with an egg-ended boiler, its entire rupture and the flight of the parts, as in No. 7 explosion, is the result."

WATER SUPPLY.

Wallasey Water Works, Cheshire.—The well for the supply of this district with water has been finished, and is a complete success. The site of the well is some 20ft. above high water level of the sea, and now that the well has been completed, the fresh water rises to some 16ft. above the level of the sea. The quicksand and rock have been reached at a depth of 94ft. from the surface, so that there is a pressure of water from beneath the marl covering nearly equal to a head of 80ft., or approaching 40lb. pressure on the square inch. When the first well had been formed through the marl, 80ft. thick, to the quicksand, the rush of water was so powerful that a solution of silt and sand alone could be pumped. The second well has been sunk by using 7ft. cast-iron cylinders. The cylinders have been sunk down to the rock, with the water in the well, without pumping. An inner cylinder, with a strong cast-iron bottom, having a socket of 2ft. diameter, was lowered to the bottom, and the joint made good by a diver working under 80ft. head of water. Boring tools were then worked through the 2ft. socket hole, and a lining, or guide-tube, driven tight into the true rock 10ft. deep, so as to shut out the solution of silt and sand. The boring into the true rock has been continued to a depth of 150ft. from the bottom of the cast-iron cylinders, or 250ft. from the surface. The water now rises up the bore-pipe soft, pure, and sparkling, of $5\frac{1}{2}$ deg. of hardness only, and may be pumped at a rate of 500,000 gallons per day. The boring tools have opened up a natural fissure in a rock of unknown capacity and depth.

GAS SUPPLY.

The Ipswich Gas Company have reduced their price from 4*s*. 6*d*. to 4*s*. per 1000 cubic feet.

The Burslem and Tunstall Gas Company have agreed to their usual dividends of 10 and 7 per cent. old and new shares, free of income tax.

CANALS.

The Suez Canal.—The Turkish Minister of Foreign Affairs has addressed a despatch to the Ambassadors at Paris and London of the Turkish Government, on the subject of the Suez Canal. The despatch relates that when the Sublime Porte first considered the question, he reserved the right to make conditions as to certain parts of the contract, and declared his desire to see a preliminary understanding established between the two maritime powers as to the guarantees which the opening of such a channel demanded. No such understanding had been come to; and in reply to a request from the Viceroy of Egypt as to how he is to regularise his position in reference to the matter, the Sultan has felt it his duty to inform him of the conditions to which the authorisation of the Sublime Porte has always been subordinate. The Porte has no intention of frustrating the work, but requires a guarantee of the neutrality of the canal, and the protection of his interests There are two facts which have attracted attention from the beginning, first, the employment of forced labour—60,000 being permanently abstracted from their homes, a practice which the Porte cannot sanction; and, secondly, the cession of territory adjoining the canals, wherever they may be carried, which might, if the company choose, give them the towns of Suez, Tenisiah, and Port Said, and lead to the establishment, on important points, of colonies almost independent of the empire. This clause of the contract will never receive the sanction of the Porte, whose consent must be indissolubly dependent on the solution of the three following questions, namely, the neutrality of the canal, the abolition of forced labour, and the abandonment by the company of the clause concerning the fresh-water canals and the cession of the adjoining territory. The despatch proceeds to say that the company cannot complain, as a clause in the contract itself makes the approval of the Porte indispensable, and M. de Lesseps, in stipulating subsequently for farther privileges, promised to obtain that consent within eighteen months, but had never done so. Although, then, the company, having commenced the works at their own risk and peril, could not complain of the works being stopped without compensation, yet, on account of the private interests involved, the Porte is willing to take the necessary measures for returning the money the company have spent, in the event of their not wishing to proceed without advantages which cannot be granted. The company would, of course, surrender the property and the works in return for the repayment, and in that event the Porte, in concert with the Viceroy, would adopt such measures as might be most appropriate for realising the execution of the work.

The East India Navigation and Canal Company.—We learn from the company's last report that the system of works suggested and now under consideration is divisible into several projects or sections, each in itself representing a work, or series of works, capable of being executed separately from the others, and having distinct sources of revenue, though capable of receiving considerable additional value by becoming a portion of the entire system, and may be described as consisting of:—First—A high level canal for irrigation and navigation from the city of Cuttack to the Port of Calcutta, passing close to the principal towns on its route, including Balasore and Midnapoor. Second—A series of works for supplying the Deltas of the Mahanuddy, the Brahmany, the Byturnee, and the Soobanreeka, and the adjoining districts of Hidjellee, Midnapoor, Burdwan, &c., with irrigation and means of water transport. Third—A main navigable tidal canal from Balasore in the Bay of Bengal, to the river Hoogley near Calcutta, accommodating the chief places on its line, such as Tumlook, &c.; and Fourth—The improvement and opening up of the Mahanuddy River, probably by means principally of a canal, in length about 135 miles, for navigation and irrigation, commencing at Puddunpore and terminating at Dholapore, both on its left bank, between which places the navigation of the river itself is dangerous, and the obstructions difficult of removal.

The Madras Irrigation and Canal Company.—We learn from the report presented at the eighth ordinary general meeting of this company, that the following is the present state of the works and the progress made:—It appears that the Anicut at Soonkasala, and the first $17\frac{1}{4}$ miles of the Main Canal are by this time finished:—the Aqueduct over the Hindry, a structure of solid stone, somewhat larger than and double the width of London Bridge, has been so far executed as to allow the passage of a body of water sufficient to irrigate a considerable extent of land below;—the five miles of Canal which immediately follow upon the Aqueduct have been completed, and along those five miles there exists some land available for irrigation;—in the next 21 miles of the Main Canal some heavy rock cutting and embanking have yet to be executed—the 12 following miles, viz., from the 43rd to the 54th mile, of the Main Canal is now complete, or nearly so;—from thence to the commencement of the Mittacondal Cutting in the 72nd mile, the work has, with the exception of some intervals of rocky excavation and heavy embankment, been executed;—which, with the Mittacondal Cutting itself, will be finished by the end of the year when the bridges, and other masonry works, such as Calingulahs and sluices, will also be completed;—from the 72nd to the 103rd mile excavation is well in hand, and there are no difficulties to be overcome;—from the 103rd to the 148th mile, the plans and estimates have been for some time past awaiting Government approval, on the obtaining of which construction will immediately commence;—the plans and estimates of the Main Line from the 148th to the 240th mile at Somaishwarum, in Nellore, are in course of completion, and about to be sent in to the Government;—the execution of the Somaishwarum Anicut has commenced, and that,—in all probability by this time the whole of the remaining works in Nellore are under construction.

DOCKS, HARBOURS, BRIDGES, &c.

Port Erin Harbour.—The Board of Trade have laid before the Honse of Commons a Bill for improving the Harbour of Port Erin, in the Isle of Man, that it may be more serviceable as a sbelter for vessels, especially those employed in the herring fishery. So soon as a pier has been so far completed as to form a shelter for a distance of 300ft. from the shore at low water certain dues are to be levied on vessels using the harbour; and the Harbour Commissioners of the Isle of Man are empowered to borrow money on the security of these dues for making the improvements. The dues are to be lowered when the payment of the expenses of maintaining the harbour permit.

The London, Chatham, and Dover Railway Bridge.—The foundation-stone of this bridge was laid on the 2nd nlt. This new railway bridge will run across the Thames only a few yards from the intended new Blackfriars Bridge. The railway bridge will have five spans, the centre one being 188ft., tbe second and fourth 177ft. 8in., and the first and fifth 163ft. span. The abutments will be of brickwork cased with Portland stone, and the foundations taken down to the city clay, at a depth of 27ft. below Trinity high water. The abutments will be built in coffer-dams of the ordinary construction, but the largest ever executed in this country. The foundations of the piers will be laid at a depth of 55ft. below Trinity high-water; and, in order to get to this depth without the expense and inconvenience of coffer-dams, large wrought-iron caissons, 18ft. in diameter, will be sunk into the bed of the river till the required level is reached, when the brick-work will be commenced inside and carried up two feet below low-water line. At this point the masonry of the piers commences, and will be laid within a temporary caisson to five feet above Trinity high-water. From this height to the level of the underside of the girders the piers will consist of clusters ot cast-iron columns, of which one will be under each girder. The girders, on the lattice principle, will rest on tbe tops of the columns, and tbe headway afforded for navigation will be 30ft. 3in. above Trinity high water.

The River Tyne Improvement Commissioners are carrying out their gigantic system of dredging with great spirit and energy. Last year tbey were supplied by Messrs. Thomas, Wingate, and Co., of Whiteinch, on the Clyde, with one of the largest deepening machines which had been then built, and it has lifted an immense quantity of dredge in Shields Harbour, at half the former cost. The same firm are constructing two of the largest and most powerful of the deepening machines in the world, which will also be shortly be lannched for the Tyne. Tbey will each be 1200 tons register, and each of the buckets employed in dredging by these machines will weigh 25 cwt. The cost of each vessel will be close upon £30,000. Nine screw hopper barges are also about to be built by Messrs. Wingate and Co., for the Tyne Commissioners. They will be 400 tons each, and will convey the dredgings of that river ont to sea. A vessel of that character is already npon the Tyne, and as an experiment it has been very successful.

Harbours of Refuge.—The annual return states that at Dover the extent of the fonndations of the Admiralty pier, or west arm of the harbour, is now 1675ft., and the length of the quay level 1539ft. The sum of £549,000 has already been voted for these works, and £60,000 will be required to be voted now, leaving £41,000 of the estimate to be voted next year; the work should be completed in November, 1864. At Alderney the onter ends of the sea and harbour walls of the western breakwater are now 1418 yards short of the limit ordered; the base of the breakwater extends to 1636 yards from the shore; 12,000 tons of stone have been deposited in the base below water. The sum of £1,027,000 has been voted for these works, and a vote of £80,000 will be required this session; the estimate was £1,300,000. At Portland the net expenditure has reached £954,260. The total quantity of rough stone deposited in this breakwater from the commencement is no less than 5,170,670 tons. The divers have uow completed tbe levelling of one-half of the area, under the foundation courses of the masonry for the north head and fort, and have set about one-third of the bottom course.

MINES, METALLURGY, &c.

The Vieille Montagne.—The famous Vieille Montagne Company, known in connection with zinc metallurgy, has made pnblic its accounts for 1863. The profits realised during the year, which was a comparatively unfavourable one, amounted to the large aggregate of £149,600, and the dividend was made at the same rate as in 1861. The price of zinc continues exceedingly low, but this very cheapness has had the effect of causing the metal to be applied to a variety of new purposes.

Sterro-Metal.—Bronze is a term applied to compounds of tin and copper; while compounds of zinc and copper are called brass. These metals in varying proportions forms the most common alloys; still there are many others, and the numbers of such is always on the increase. As various metals may be mixed in different proportions, and as a slight variation in the quantity of any one component produces a new alloy of a different character, the number and quality of alloys may be extended indefinitely. The new alloy, called "sterro metal," is composed of pure American copper, 57·63 parts by weight; spelter (block zinc), 40·22 parts; iron, 1·86; tin, 0·15. It has a brass-yellow colour, a close grain, and susceptible of a fine polish. This alloy is stated to possess great strength, a square inch of it, after heing forged while red hot, sustained a strain of 28 tons before it broke. It can be drawn cold and forged like iron. The tensile strength of common gun-metal is only 17 tons per square inch, which is but little more than half the strength of sterro-metal.

Production of Gold and Silver in the United States.—An interesting lecture was delivered before the Geographical and Statistical Society of New York, by Mr. J. Smith Homans, on the production of gold and silver throughout the world, but particularly in the United States; some valuable information was imparted. He stated that though the amount of gold already obtained from the Pacific States was immense, the mineral resonrces in that region were, in the opinion of scientific explorers, as yet comparatively undeveloped. The gold region extends through 17° of latitude, and comprises an area of 17,000,000 square miles. The yield of the year of exportion, ending last July, was more than 100,000,000 dollars. So marvellous a development of mineral resources must eventually create a vast empire, with a commerce far surpassing anything yet known in the history of the world. The great influence which the United States have exercised upon mercantile affairs since the gold discoveries were fully set forth, and the indebtedness of Europe to this country on account of gold supplies were illustrated by the following statement:—

Export of gold from the United States for the years

1848	15,841,616 dols.	1856	45,745,485 dols.
1849	5,404,648 „	1857	69,136,922 „
1850	7,522,994 „	1858	52,633,147 „
1851	29,472,752 „	1859	63,887,411 „
1852	42,674,135 „	1860	66,546,239 „
1853	27,486,875 „	1861	29,791,084 „
1854	41,436,456 „	1862	36,886,956 „
1855	56,247,343 „		
		Total fifteen years	590,714,059 „
		Deduct foreign imports	157,036,698 „
		Excess of exports	433,677,361 „

APPLIED CHEMISTRY.

On the Relation of Vital and Chemical Force to the Potential Energies of Matter, by James Croll.—The following relation between vital and chemical force which does not appear to have been specially noticed by physicists, seems to follow as an obvious deduction from the principle of the conservation of force:—The greater part of all the force available for mechanical purposes is derived from chemical combination. Chemical combination, again, depends npon the affinity of the atoms—their tendency to approach and unite. The greater this affinity, the greater is the force, or, according to tbe dynamical view, the velocity with which they approach. The heat produced is also proportional to the affinity of the atoms; for the amount produced is proportional to the *vis viva* of the moving atoms at the moment of union. The force manifested in chemical combination we say existed in the atoms previously in a potential state. Potential energy is transformed into actual energy by the mutnal approach of the atoms under the impulse of their affinities. Potential energy can therefore only be restored to the atoms by pulling tbem asunder again. Chemical change consequently in every case rednces the total amount of potential energy possessed by matter and increases its actual energy. It is true that decomposition in most cases occurs along with combination, but the potential energy gained from the decomposition never can equal the amount lost by the accompanying combiuation. By what means, then, does matter regain its potential energy? The agency of heat alone is not sufficient, for although heat expands bodies by separating their molecnles, yet it does not, except in a few cases, separate the atoms chemically united. Neither can it be done by the electric current, for the potential energy gained by electrolysis does not compensate for what is lost in generating the current. The atoms of matter seem to be indebted to the agency of vital or organic forces for the restoration of their potential energies. Chemical agency separates the atoms possessed of weaker affinity, in order that they may unite with others to which they have a stronger affinity. Vital agency, on the contrary, separates atoms which have a stronger affinity in order to unite them with others to which tbey have a weaker affinity. In the latter case we have a restoration of potential energy. But potential energy can only be restored at the expense of actual energy. Where, then, does the vital agent derive its supplies of actual energy? Evidently from the sun's rays. Here we have two agencies constantly at work—the chemical and the vital. The former is continually converting the potential energy of matter into actual energy by the motion of tbe atoms towards each other. The latter, on the contrary, is continually restoring the potential energy lost by drawing the atoms asunder. The chemical agent produces actual energy by means of the consumption of potential energy; the vital agent restores the potential energy by consuming actual energy, viz., the sun's rays.

Experiment on the Separation of Sal-Ammoniac into Hydrochloric Acid and Ammonia at the Moment of Vaporisation, by M. L. Penal.—It is known that M.M. Cannizzaro and H. Kopp explain the abnormal condensation of the vapour of certain bodies, such as sal-ommoniac, hydriodate of phosphoretted hydrogen, perchloride of phosphorus, monohydrated sulphuric acid, &c., by supposing that bodies during vaporisation are in a state of dissociation, as M. H. Deville happily expresses it. If sal-ammoniac gives 8 volumes of vapour ($H_2 O_2$ = 4 vols.), it is owing, according to these authors, to the fact that the vapour of sal-ammoniac is a mixture of hydrochloric acid and ammoniacal gas. M. Keknle entertains the same idea. But there has hitherto been no direct experimental proof of this theory; though with respect to sal-ammoniac the author has furnished this proof. The method he employed is new only in its application to this present research. M. Bunsen has shown that to decide whether a gas consists of a single or compound substance there are only two experimental solutions,—namely, by absorption and diffusion. In the case in point, it would be difficult to apply the method of absorption; by experimenting by the method of diffusion the solution of the question might be determined. In fact, if sal-ammoniac vapour is really formed of a mixture of ammonia and hydrochloric acid, it is evident the least dense gas, ammonia, onght to pass by diffusion more rapidly tban hydrochloric gas into a hydrogen atmosphere. Supposing such a diffusion effected, the hydrogen atmosphere, after a certain time, should contain free ammoniacal gas, while the free hydrochloric gas should appear in the atmosphere of the sal-ammoniac vapour. This theoretical assumption has been proved to be correct hy the following experiment:—Place some fragments of sal-ammoniac on a plug of amianthus in a tube drawn out at one end, and fixed inside a larger one. The tubes are traversed by a current of hydrogen, while, by means of a furnace of incandescent charcoal, their temperature is raised sufficiently to volatilise the sal-ammoniac. The sal-ammoniac vapour being formed above the amianthus plug, ammoniacal gas penetrates through the plug in quantity sufficient to blue litmus-paper placed in the course of the hydrogen which sweeps through the inner tube, while the hydrogen traversing the annular space hetween the two tubes, the atmosphere of which is impregnated with excess of hydrochloric acid, reddens blue litmus-paper placed across its passage. It is thus made evident that the sal-ammoniac contains free hydrochloric acid and free ammonia, for these two gasses passed through the diaphragm in unequal proportions. The use of such metals as mercury and platinum has been purposely avoided, to escape the objection that might be urged by intervention of decomposing or catalytic forces.

Analytical Notices on Arsenic, by M. H. Rose.—Arsenic may be estimated by difference in many of its combinations with metallic oxides, by calcination of the substance with sulphur; the arsenic volatilises as sulphide, the base remaining under the form of mixed sulphide. The operation is easily effected in a hydrogen current, but is especially successful with arseniates of manganese, iron, zinc, lead, and copper. Calcination with sulphur in a porcelain crucible completely eliminates the arsenic of arseniates of nickel and cobalt; but the weight of nickel and cobalt cannot be calculated from the residual sulphide. Arseniate of silver, heated in a hydrogen current, or with sulphur, leaves silver which obstinately retains a certain quantity of arsenic. The alumina resulting from the calcination of arseniate of alumina in a hydrogen current, whether singly or with sulphur, also invariably retains arsenic. It is the same with the magnesia resulting from ammoniaco-magnesian arseniate. The above process applies, of course, to many metallic arsenides, particularly to arsenical iron, to mispickel (arsenio-sulphide of iron), to arsenical nickel, and to grey cobalt (arsenio-sulphide of cobalt), though with greater difficulty. Grey cobalt must be previously oxidised by nitric acid, and the mixture of oxides then treated by sulphur; and this must be repeated several times. In many instances the best way to expel arsenic acid from arseniates is to calcine them with hydrochlorate of ammonia. Alkaline arseniates are perfectly transformed into chlorides by a single calcination; arseniates of alkaline earths offer more resistance, and the magnesia of the arsenic always retains a certain proportion of arsenic. Many oxides of true metals are reduced to a metallic state by calcination with sal ammoniac; but the metal will contain arsenic. Bisulphate of ammonia, as shown by M. H. Finkener, can often advantageously replace the hydrochlorate. However, the fused bisulphate attacks the porcelain crucible, which must be used on account of the arsenic, and the sulphates obtained are mingled with those produced by this attack. The arsenic is generally entirely expelled. The author has ascertained this to be the case with ammonia-magnesian arseniate, with arseniates of soda, lime, and lead. Arsenides of nickel and cobalt are more easily freed from arsenic by this method than by fusion with sulphur. Some few metallic arseniates may be decomposed by boiling with a solution of a hydrated or carbonated alkali. The author in this way has been successful with arseniates of peroxide of iron and copper; arseniates of zinc and protoxide of manganese yield oxides retaining notable quantities of arsenic.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated April 25th, 1863.

1035 L. A. J. Bruet—Registering, indicating, and verifying the time and distance passed over by vehicles.
1036 A. Poirrier & C. Chappat—Blue and violet colouring matters.
1037 F. Walton—Fabrics for covering floors and other surfaces
1038 C. Beyer—Safety valves.
1039 I. Dimock—Cleaning, sorting according to size, and doubling silk.
1040 A Legras—Making ices.
1041 J. T. Stroud—Holding, drilling, turning, tapping, fitting, and shaping certain parts of steam, water, gas, and lamp fittings.
1042 W. E Newton—Thrashing machines.
1043 A. V. Newton—Breech-loading fire-arms.
1044 M. Barland—Milking cows.

Dated April 27th, 1863.

1045 S. Osborne—Unwinding crinoline steel.
1046 G. Spill, T. J. Briggs, and D. Spill—Mill straps and driving bands.
1047 H. E. Carchon & E F. Raybaud—Hats and bonnets.
1048 J. J. Robert—Spoons and forks.
1049 W. E. Gedge—Blast pipes.
1050 M. Valkenhuyzen—Castor for furniture.
1051 W. Richards—Ordnance, fire-arms, and cartridges.
1052 J. Jeffreys—Surface condensers.
1053 F. Bennett — Condensing lead and other metallic fumes and vapours from furnaces.
1054 R. A. Brooman—Twisting and doubling silk.
1055 W. H. James—Indicating the locality of fire.
1056 W. Hudson & C. Catlow—Looms for weaving.
1057 A. Rollason—Dyeing and staining fabrics.
1058 H. Beare—Thrashing machines.

Dated April 28th, 1863.

1059 S Ingledew—Obtaining iron from its ore.
1060 J. & W. Marris—Breaking loaf sugar.
1061 S. Crabtree—Balling motions.
1062 G. Hall & J. Wells—Explosive compound.
1063 A. Kinder—Sheet metal.
1064 W. Clark—Paper.
1065 G. W. Fuller—Submarine lantern.
1066 J. H. Johnson—Drying and cooling grain.
1067 J. H. Johnson—Preserving property in case of shipwreck.
1068 G. S. Macdonald—Card cases.
1069 T. Moore—Laying down, protecting, and controlling submarine cables.
1070 R. Butterworth—Carding cotton and other fibrous substances.
1071 G. Davies—Agitating and mixing substances
1072 G. E. Donisthorpe—Getting coal and other minerals.
1073 H. Y. D. Scott—Cementitious substances.
1074 S. S. Marling—Scouring, washing, and cleansing woollen cloths.

Dated April 29th, 1863.

1075 J Rowley—Recovering the fibres of wool from fabrics or materials composed of wool combined cotton or other vegetable substances.
1076 E. Rowland—Weighing solid bodies and measuring fluids.
1077 W. & E. Tarr—Pianofortes.
1078 W. E. Gedge—Permanent advertisement.
1079 E. & F. A. Leigh—Cotton gins.
1080 W. Rodger—Anchors.
1081 H Worms—Elevating guns.
1082 M. Barland & E. H. C. Moockton—Milking cows.
1083 F. Greiton—Heating the contents of mash tuns.
1084 G. Holcroft—Pyrometers.
1085 H. W. Ripley—Printing fibrous materials.
1086 M. Henry — Beton and artificial stone and pugging clay.

Dated April 30th, 1863.

1087 J. Wibberley—Winding cotton, silk, wool, or other threads on spools or reels.
1088 A. H. Remond—Retaining the aroma of coffee and cocoa.
1089 W. Clark—Hydrocyanite of ammonia and alkaline and earthly cyanides.
1090 E. Mitchell—Reaping and mowing machines.
1091 E G. Brewer—Welding and rolling metals.
1092 C. P. Stewart & J. Kershaw—Obtaining compressed air and applying the power thereof in propelling railway and other carriages.
1093 J. Appleby—Propelling ships and barges.
1094 J. H. Johnson—Rotatory engines.

Dated May 1st, 1863.

1095 J. McFarlane Gray—Rivetting, caulking, chipping, and otherwise operating upon and treating metals and other substances.
1096 E. Jones—Drainage.
1097 W. Clissold — Fulling woollen cloths and washing and cleaning woven fabrics.
1098 W. G. Craig — Feed apparatus for steam boilers.
1099 J. Badart—Preparation of rape seed and other oak's.

Dated May 2nd, 1863.

1100 T. L. Bissell—Charging breech-loading cartridges.
1101 W. T. Smith—Washing machines.
1102 J. W. Gibson & W. Turner—Springs for railway buffers.
1103 G Burt — Punching, stamping, or forging metals.
1104 J. Purdey—Breech-loading fire-arms.
1105 S. J. Bartlett — Straining and drawing off
1106 J. B. Dubreuil—Carts, waggons, and other
1107 J. T. & T. Oakley—Garden pumps.
1108 H. Myers—Appointment clock.

Dated May 4th, 1863.

1109 E R. Southby—Extraction of scents from plants and flowers.
1110 J. Fortune—Fastening together lace, blond, quilling, or similar materials.
1111 J. M., E., & C. Johnson & L. Bertling—Show tablets
1112 B G. Sloper—Separating metals from earthly and other matters mixed with them.
1113 G. Haseltine—Springs for railway carriages.
1114 F. Applegate—Spring balances and pressure gauges.

Dated May 5th, 1863.

1115 J. H. Johnson—Wrought iron and steel.
1116 W. Walsh—Obtaining and purifying oxalate of soda.
1117 R. G. Kent—Shades and reflectors for gas lights.
1118 E C. Chesshire—Intercepting the solid portions of the soil of water closets.
1119 W. Boothroyd—Stationary engines
1120 R. A. Brooman—Fabric suitable for trimmings.
1121 F. Applegate—Stopping and starting railway trains.
1122 P. Bradshaw—Mounting mill stones for grinding grain.
1123 J. H Knott—Pumps.
1124 W. Glover—Facilitating the steering of ships and other vessels.
1125 W. C. Wilkins—Lamps.
1126 S. B. Cochran—Sewing machines.

Dated May 6th, 1863.

1127 T. Sagar & J. Wilkinson—Power looms for weaving.
1128 J. T. Ward—Carriages.
1129 W. E. Gedge—Toy.
1130 S. Hibbert, J. Lawton, & J. Kay—Cleansing potatoes.
1131 S. D. MacKellen—Watches and other time-keepers.
1132 I. M. Singer—Sewing machines.
1133 G. Davies—Forging and dressing horse-shoe and other nails.
1134 T. Beesley—Boxes for carrying and packing boxes.
1135 A. Sturrock—Locomotive engines and tenders.
1136 C. W. Atkinson—Steam or other motive power engine.
1137 A. V. Newton—Sewing machines.

Dated May 7th, 1863.

1138 J. Park—Communicating motion to machinery for manufacturing paper pulp.
1139 J. Snider — Breech-loading fire arms and ordnance.
1140 P. Bourne—Miners' lamps.
1141 J. Walker—Mechanism applicable to looms and partly to carding engines.
1142 A. Stanley—Finishing clasps and other metallic connectors.
1143 G. Bower & A. Dick—Purification of gas for illuminating purposes, and the reduction of ores and the melting of metals.
1144 T. Small—Motive power machinery.
1145 J. Bettridge—Ornamentation of papier mache and other japanned wares, wood, ivory, and other similar materials.
1146 C. A. Day, A. Lamb, & T. Summers—Marine engines.
1147 J. B. P. A. Thierry—Furnaces to render the combustion of the fuel more complete, and to prevent the emission of smoke there from.
1148 T. Holliday—Blue colouring matter.

Dated May 8th, 1863.

1149 P. J. Livsey—Compound steam engines.
1150 A. Skwarcow—Turntables.
1151 H. Schooling—Shaping lozenge paste or other plastic materials
1152 J. S. Grimshaw—Looms for weaving.
1153 C. L. Braithwaite—Feeding slivers of wool and other material to carding engines.
1154 J. H. Bailey—Mechanical movement for producing an impelled current of air for lamps.
1155 J. C. Droop—Instrument for holding nails, screws, or other fastenings.
1156 W. Clark—Coating wrought or other iron to protect it from corrosion or oxydation.
1157 E. C. Boet—Tanning hides and skins.
1158 C. F. Bielefeld—Sheets, slabs, and other articles where fibrous materials are employed.
1159 G. T. Bousfield—Steam engines.

Dated May 9th, 1863.

1160 W. Thomson—Obtaining motive power.
1161 J. Hickland—Laying veneers on to surfaces and applying the glue for that purpose.
1162 S. Wilson—Hoops or bands for fastening bales.
1163 W. E. Gedge—Paper, stuff, or pulp from certain vegetable substances.
1164 J. Norie—Moulds for casting.
1165 J. Page & A. T. Wayne—Pens.
1166 J. Brierley—Dyeing knickerbocker and textile fabrics.
1167 W. Bosler—Dryer fabric for paper making.
1168 E. R Clark—Portable wine cases or bins for domestic use or export and a picnic chest combined.
1169 V. Legendre—Scissors.
1170 R. A. Brooman—Lamp black.
1171 J. B. Wood—Defending ships or vessels and forts when armour plating is employed.
1172 J. Burrell — Cutting the teeth of bevelled wheels.
1173 C. H. G. Williams—Colouring matters.
1174 J. Borrell—Salinometers.
1175 J. H. Johnson—Rotatory engines.
1176 J. Lee & M. Gutteridge—Agricultural implements.

Dated May 11th, 1863.

1177 B. Hargreaves—Tiles for drainage or sanatory purposes.
1178 R. Burgess—Marking, etching, or engraving cylindrical and other surfaces.
1179 C. & W. Shorrock—Power looms for weaving.
1180 C. L. V. Tenac—Railway rolled wrought iron sleeper.
1181 C. L. V. Tenac—Armour plates of hammered or rolled wrought iron, the whole of the rivets being protected against the direct blows from the cannon shots.
1182 J. Parkinson—Tablets.
1183 R. A. Brooman—Coupling and disconnecting carriages on railways.
1184 J. S. Guirette—Inhaling apparatuses.
1185 J. Shanks—Cutting the edges of grass.
1186 J. E. McConnell & G. H. Bovill—Chains for cables and other purposes.

Dated May 12th, 1863.

1187 B. Lilly—Nipple protectors for fire arms.
1188 W. Mattison & G. Barker—Grass mowing and reaping machines.
1189 T. Warren—Glass and other furnaces.
1190 H. Wickens—Reaping and mowing machines.
1191 J. E. McConnell & G. H. Bovill—Treating worn out railway tyres.
1192 W. Whiteley—Looms for weaving.
1193 G. A. Huddart—Cutting slate.
1194 H. L. Emery—Saws for ginning cotton.
1195 R. A. Brooman—Spring mattresses.
1196 R. A. Brooman—Spring mattresses, sofas, chairs, and seats.
1197 R. A. Brooman — Preparing, dressing, and winding cotton, woollen, flax, silk, and other warps.

Dated May 13th, 1863.

1198 H. Rushton—Head-dresses.
1199 R. A. Brooman—Laying submarine telegraph cables.
1200 H. Wilde—Electro-magnetic telegraphs.
1201 T. Parkinson & F. Taylor—Weaving, sizing, dressing, and dyeing.
1202 F. Holthausen—Portable copying press.
1203 J. E. McConnell & G. H. Bovill—Wrought iron armour plates.
1204 V. J. Cassaignes—Stereoscopes.
1205 C. L. Kensner—Hydrate of barytes and sugar.
1206 B. Lamhert—Rag or pulp engines.
1207 A. G. Southby—Railway roof lamps, station, signal, and other fountain lamps.
1208 J. Farmer—Calendering, embossing, and other such machines.
1209 R A. Brooman—Extraction of hydro-carburets from minerals.

Dated May 14th, 1863.

1210 T. Lawrence — Drying, dressing, brushing, waxing, and finishing fabrics.
1211 J. Satchwell, W. H. Ashford, & C. Harrison—Nails or rivets for boots and shoes.
1212 A. Pilbeam—Sewing machines.
1213 J. T. King—Wicks for oil and other fluid burning lamps.
1214 J. Burrell—Cocks or valves.
1215 G. Dowler—Match boxes.
1216 L S. Chichester—Weighing grain.
1217 F. K. Erlam—Lubricating compound.
1218 G. T. Bousfield—Rolling, grinding, and cutting files and rasps.
1219 I. Parker—Connecting and securing door and other knobs or handles to their spindles.

Dated May 15th, 1863.

1220 B. Shillito & D. Moor—Generating heat and
1221 D. M. Fyfe—Painting the centres of military or other targets.
1222 D. M. Fyfe—Raising, removing, transporting, and refixing military or other targets.
1223 W. Clark—Repeating fire-arms.
1224 A. Macmillan—Buttons.
1225 R. T. Mallet—Piers, walls, and landing stages.
1226 J. Patterson—Grinding, crushing, cleaning, and shelling farm or vegetable produce.
1227 J Papin, C. Lintz, and L. Lavachcrie—Boots and shoes.

Dated May 16th, 1863.

1228 R., W., and T. Waddington—Combs.
1229 B. Browne—Elastic material.
1230 J. Hinks—Lamps.
1231 R. Talbot—Folding rudder.
1232 F. M. Burns—Preventing the fouling of the bottoms and sides of ships.
1233 W. Clark—Rotatory engines.
1234 J. T. Newton—Planishing and rolling sheet metal.
1235 J. Gibbs—Preparing and spinning flax.
1236 W. White—Looped fabrics.
1237 T. C. Stretton—Dressing lace.
1238 E. B. Wilson—Iron and other metals.
1239 J. Whitehead—Motive power machinery.

Dated May 18th, 1863.

1240 E. Christmas—Carriages.
1241 W. Watson—Bread.
1242 H. Bennett—Facilitating the puddling of iron.
1243 A. Heather & J. Redfern—Steam boilers.
1244 B. Hebblewhite—Crushing or reducing oil coke, seeds, and other substances.
1245 R. Fenuer & W. H. Hight—Envelope folding machines.
1246 S. Toy—Screw rivets, nails, or pins.
1247 J. Beaumont—Condensing machines for working yarns of wool and other fibrous substances.

Dated May 19th, 1863.

1248 C. Barnard, J. Bishop, & C. & G. Barnard—Lawn mowing and rolling machines
1249 S Rhodes—Twisting and doubling cotton, hemp, and flax.
1250 J. Edwards—Permanent way of railways.
1251 J. H. Johnson—Breech loading fire-arms.
1252 F. Fenton—Treatment of vegetable fibres for the preparation of textile materials therefrom.
1253 R. Bunting—Frames, tips, and bolsters used in cutlery.
1254 H. J. Olding—Treating flax and other fibrous plants.
1255 J. Kelly—Treatment of peat.
1256 A. Parker—Saving from destruction by fire persons and property.
1257 L. Chaudor—Mechanical lamp.
1258 T. P. Salt—Trusses.
1259 L. Chaudor—Lamps.
1260 W. Smith—Transferring plain or coloured prints or designs to wood or other surfaces.

Dated May 20th, 1863.

1261 H. Wren & J. Hopkinson—Self-lubricating bearings for shafts and axles.
1262 J. Coignard—Sewing machines.
1263 W. J C. Lang—Preserving life at sea.
1264 P. Addington—Varnishes.
1265 R. R. Jackson & W. Pemberton—Looms for weaving.
1266 T. Williams & I. Naylor—Paper spools used in spinning and doubling machines.
1267 J. T. Markall—Working wood.

Dated May 21st, 1863.

1268 J. Cassell—Treatment of mineral oils and hydrocarbons.
1269 G. R. Harding—Transmitting power on railways worked by vacuum or the pressure of air.
1270 W. Walker—Looms for weaving.
1271 J. Steart—Extracting the fibre from zostera marina and other aquatic vegetable productions.
1272 W. Munn—Signal lanterns.
1273 F. P. Warren — Attaching copper or other sheathing to iron vessels.
1274 E. T. Hughes—Breech-loading fire-arms and cartridges.
1275 N. J. Amies—Elastic webbing.
1276 A. Thornalley—Brick kilns.
1277 W. H. Clapp—Rail or holder for coats and other articles.
1278 E. Sonstadt—Purification of magnesium.
1279 J. Pawcett—Preparation of food for cattle, horses, and other animals.
1280 J. Goodman—Velocipedes and wheels for the same.
1281 R. A. Brooman—Breech-loading ordnance and other small arms and projectiles.

Dated May 22nd, 1863.

1282 W. Snell—Butt hinges.
1283 C. Maschwitz—Bungs for stopping bottles, jars, and other vessels.
1284 T. A. Blakely—Ordnance.
1285 J., J., & M. H. Habershon—Rolling, polishing, straightening, and tapering round rods or bars of iron, steel, and other metals.
1286 T. A. Blakely—Rifling guns and forming projectiles to correspond therewith.
1287 G Stevens— Coke ovens, and building and heating ovens or retorts for generating coal gas connected therewith.
1288 W. E. Newton—Manufacture of waterproof fabrics.
1289 W. E. Newton—Manufacture of waterproof fabrics.
1290 J. Higgins & T. S. Whitworth—Roving, spinning, and doubling cotton.
1291 A. W. Hofmann—Preparing colouring matters for dyeing and printing.

Dated May 23rd, 1863.

1292 J. Sturgeon—Steam hammers.
1293 E. Barlow, J. Newhouse, F. Hamilton, and W. Hope—Carding engines and lap machines, and machinery for grinding card teeth.
1294 J. A. Pickering—Covers for bottles, jars, and similar vessels.
1295 W. Cormack—Distillation of mineral or vegetable oils and spirits.
1296 S. E. Rosser and J. G. Jennings—Chimneys, fire places, stoves, and flues for warming and ventilating apartments.
1297 J. S. Bickford and G. Smith—Firing explosive compounds.
1298 W. Hoey—Preparation of a fluid for renewing the surface of japanned and enamelled leathers and cloths.
1299 J. Hopkins—Crossings on railways and tramways.
1300 F. Potts and J. Key—Iron tubing.
1301 R. A. Brooman—Indicating the position of trains upon railways.
1302 R. A. Brooman—Bells.
1303 R. A. Brooman—Safety garments.
1304 F. Kingsbury—Orchestras.
1305 G. Smith—Lamps for burning hydro-carbon oils.

Dated May 25th, 1863.

1306 J. Hesford—Stretching and drying cotton.
1307 W. Muir—Cutting and assorting sugar.
1308 G. Howell—Stamping and printing machine
1309 H A Bonneville—Carriages
1310 P Leprovost—Carriages and vehicles
1311 E Hunt—Posts or pillars for fences or gates
1312 G Gottgen—Binding for trimming woollen cloth garments
1313 H B Girard—Heating apparatus
1314 T Spurrier—Ornamental metal cylinders
1315 J Hillior—Frames, sashes, shutters, blinds, and ventilators for windows
1316 C Hare—Reclining and easy chairs
1317 R Hayward—Bottling and drawing off liquids
1318 M J Roberts—Preparing, spinning, twisting, and doubling wool and cotton
1319 J W Burton, S G Rhodes, S E Seanor, and W Scruton—Getting coals or other minerals
1320 W Clark—Ruling paper

LOCOMOTIVE ENGINEERING.

FIG 1 FENTON MURRAY & JACKSON (LEEDS)

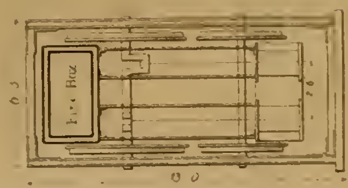


FIG 2 STEPHENSON

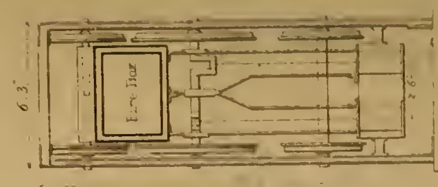


FIG 3 BURY

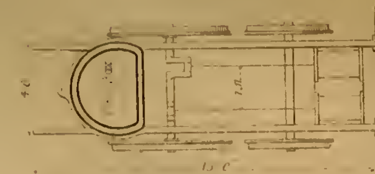


FIG 4 BURY'S IMPROVED

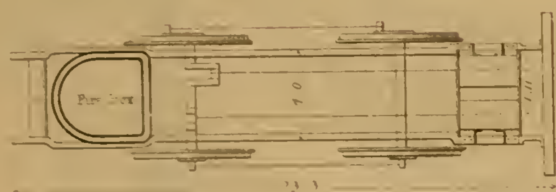


FIG 5. SHARP & FAIRBAIRN

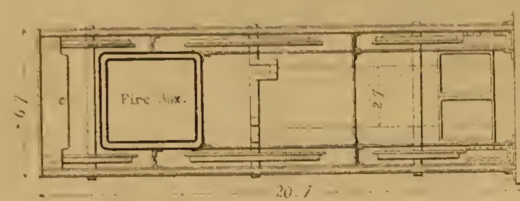


FIG 6 STEPHENSON

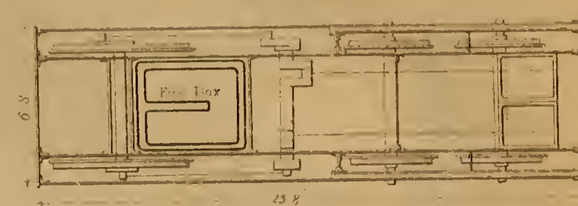


FIG 7 FAIRBAIRNS IMPROVED

FIG 8. ALLAN.

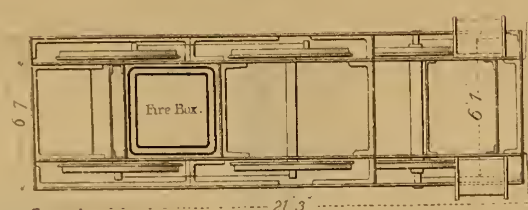


FIG 9 STURROCK & KIRTLEY

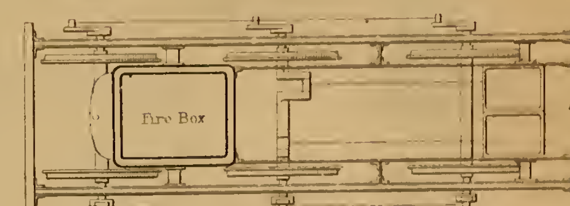


FIG 10 GOOCH

FIG 11. HAWTHORN.

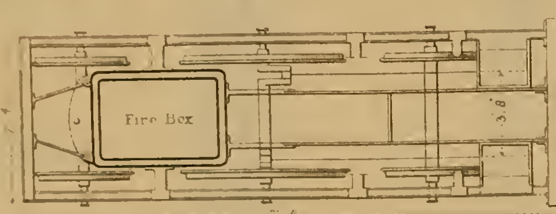


FIG 12 ADAMS

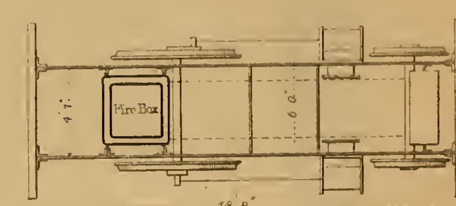


FIG 13 STEPHENSON

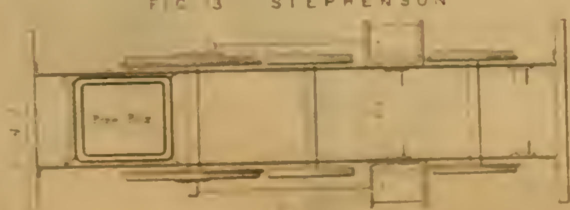


FIG 14 SINGLE FRAMED INSIDE CYLINDER ENGINE.

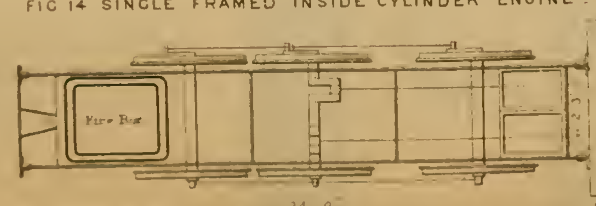
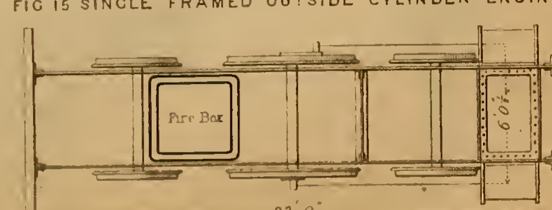


FIG 15 SINGLE FRAMED OUTSIDE CYLINDER ENGINE.



LOCOMOTIVE ENGINEERING.

WATER SUPPLY.

FIG. 1.

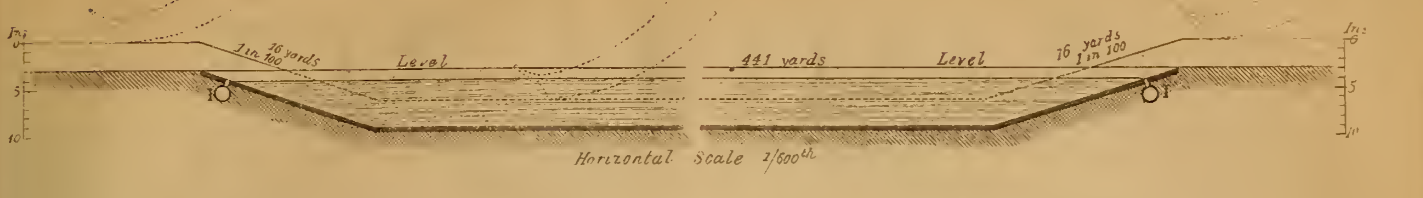


FIG. 2.

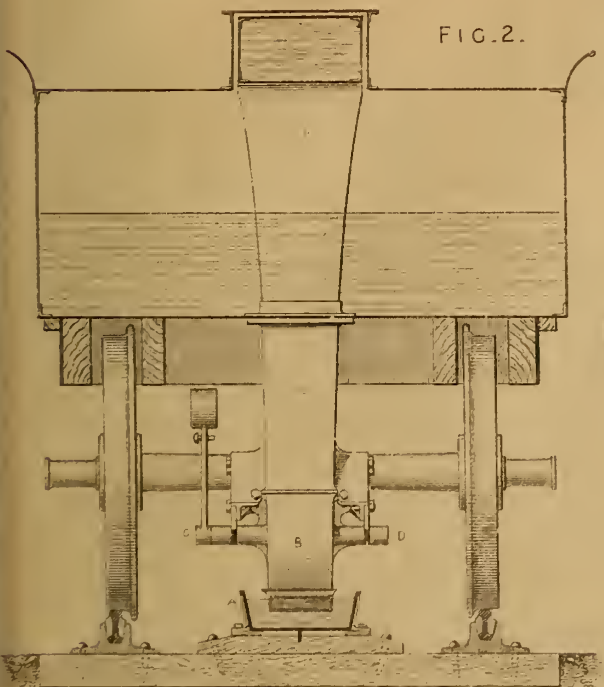
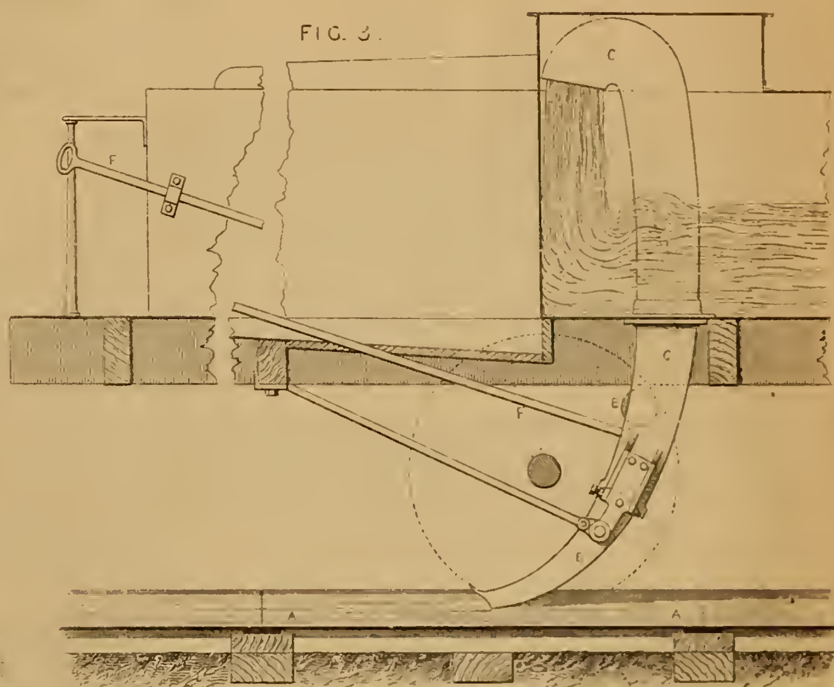


FIG. 3.



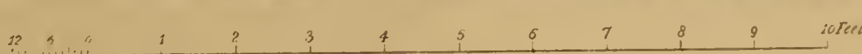
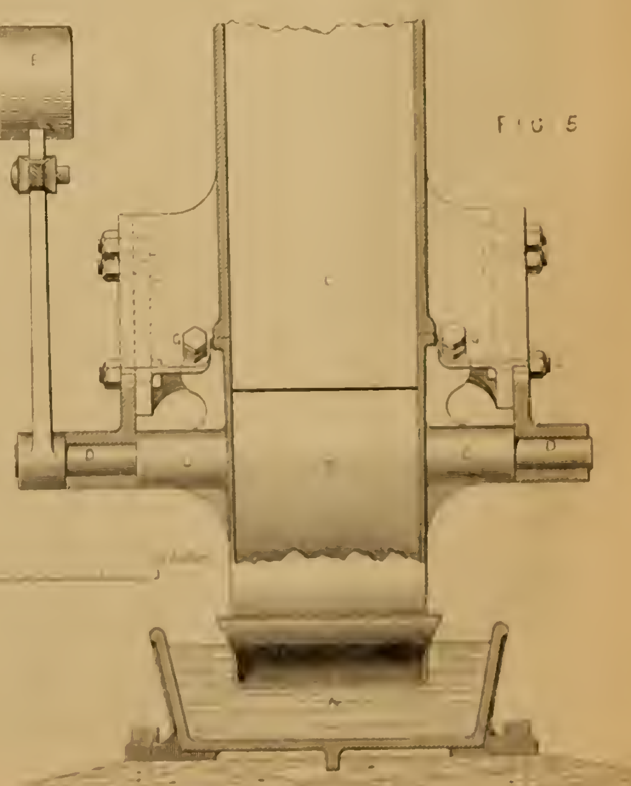


FIG. 4

FIG. 5



THE ARTIZAN.

No. 7.—Vol. 1.—Third Series.

JULY 1st, 1863.

A CRITICAL AND HISTORICAL REVIEW OF LOCOMOTIVE ENGINEERING.

By J. J. Birckel.

(*Illustrated by Plates* 245 *and* 246.)

(*Continued from page* 125.)

In the early attempts at propelling carriages upon railways by means of steam, it was deemed indispensable to make the rails in the shape of a toothed rack, and to provide the driving wheels with cogs fitting into this rack—an idea originated, we believe, by Trevethick, to whom the world is indebted for the first attempts at introducing the steam engine upon tramways. This method of propulsion, however, was anything but satisfactory, being necessarily attended with frequent breakages; and, as it was soon ascertained that, with an adeqnate load upon the driving wheels, the simple adhesion upon the rails was quite sufficient for all purposes of traction, the cog wheels and the racks were dispensed with. But to Pambour must be ascribed the merit of having defined the ratio of the adhesion to the load npon the wheels, in the same series of experiments to which we have referred in our paper on train resistances. In those experiments he ascertained that this force could amonnt to $\frac{1}{7}$th, and was never less than $\frac{1}{27}$th the load upon the wheels; and, though it has since been found that it may amount to even $\frac{1}{5}$th, and that it is seldom less than $\frac{1}{13}$th, yet does this in no way diminish the merit due to Pambour of having ascertained the practical limits of that force.

This ratio being known, when once the load upon the several pairs of wheels is distributed with a due regard to the stability of the engine, as has been observed in our paper on this subject, it remains for the engineer to ascertain whether the requirements of the traffic, and the physical conditions of the road for which the engine is intended, demand the coupling of either pair of wheels to the driving wheels proper. As a general rule light goods engines have the front wheels coupled, and passenger engines for heavy traffic have the trailing wheels coupled. These, though carrying less weight, in the latter instance, meet all the requirements of traction, and thus relieve the front wheels from any work but that of leading the engine, which is their legitimate duty. This class of engines, with trailing wheels coupled, which is, so to speak, the stereotyped passenger engine of the Northern States of America, is gradually being called into more frequent requisition in this country.

Finally, now it remains for us to enquire into the question of transmitting the tractile power of the engine to the train; a question which resolves itself wholly into that of the correct construction of the frame.

In the earlier locomotives the boiler itself formed the frame proper of the engine, and upon it were fixed in various ways the cylinders, while through it also was transmitted the force of traction to the train, generally by attaching the draw-bar to the back of the fire-box—nor does it appear that the introduction of the frame itself was, in the first instance, so much the result of a correct knowledge of the real wants of the case, as that of a desire to procure better means of attachments for the axle box guides, for in the engines first provided with them by Fenton, Murray, and Jackson, and also by Stephenson, they acted as carrying frames only, as is plainly seen by inspection of diagrams, Figs. 1 and 2 (Plate 245), the cylinders, in both cases, being attached to the smoke-box end of the boiler, and the draw-bar to the fire-box. This want of knowledge, however, is not to be wondered at when it is remembered that steam engineering the real wants of which could be ascertained by experience alone, was then still in its infancy, and that the whole question was of necessity in the hands of artizans, untutored in the science of theoretical mechanics which, at that time, was only accessible to those well versed in the higher branches of mathematics.

It is a singular fact that Bury, who was the first to introduce a continuous and rigid frame, running inside the wheels, from end to end of the engine, as shown by diagram, Fig. 3, did not in the first instance seize upon the opportunity thus afforded of pulling directly through the frame, but still attached the cylinders to the smoke-box, and the draw-bar to the fire-box, thus causing the force of traction to be transmitted through a circuitous route from the boiler to the frame, and from the frame again to the boiler by means of side stays, which were easily deranged, and which have been up to this day a never failing cause of leakage in the boiler, in all cases where they have been preserved.

Yet, though Mr. Bury failed to derive immediately from his contrivance all the advantages which it embodied, one great benefit was realised in the fact of having the driving wheel, the axle bearing and the crank as close to each other as possible, an arrangement which is quite indispensible to ensure the safety of the crank axle. Besides this, he soon also realised the benefits of direct connection by attaching the cylinders to the frames, and by constructing a draw-box quite independent of the boiler, by means of which also the frames were rigidly bound together at the back of the engine, as illustrated by diagram, Fig. 4. To him, therefore, must be justly ascribed the merit of having been the first to construct an engine in which the duties allotted to the boiler and to the carriage were such as to ensure efficiency with endurance, and which was the means to clearly define the very distinct functions of these two great constituent parts of the engine, viz., the frame and the boiler.

Bury's arrangement, however, while completely dispensing with the outside frame, and so far simplifying the machine, made at the same time a great inroad upon its structural beauties, since the more graceful and regular contour of the outside frame gave way to the sight of irregular wheel spokes, and of a roughly-shaped inside frame, the construction of which could not in the state of the art of forging or of rolling iron at that time, be influenced by any considerations of æsthetics. It also placed the engine upon a much narrower foundation, a circumstance which, it was not unreasonably feared, would materially affect its steadiness upon the rails. On these grounds some engineers have adhered to the outside bearings, but in order to protect the crank axle, they have provided also an inside bearing upon a frame placed inside the wheels which was stopped short at the fire-box, as in the case of Sharp's and Fairbairn's engines, illustrated by diagram, Fig. 5, where the cylinders were attached to the inside frames, and these firmly rivetted by means of vertical and horizontal cross-stays to the outside ones in order to obtain rigidity for the purposes of traction. This arrangement, however, still caused the force of traction to traverse a very circuitous route; and as the inside frame was stopped only for the purpose of gaining a couple of inches in width of fire-grate, while the means of supporting it, and of carrying the boiler at the fire-box end were thus rendered very difficult and expensive, it may with reason be said that the gain looked for was not an adequate compensation for the extra trouble incurred, coupled with the loss of the advantages of direct connection. At a later date this defect was remedied both by Stephenson and by Fairbairn, as illustrated in Fig. 6 and 7, in both which cases the wide carrying base has been preserved, while the crank axle is well protected and the line of traction is unbroken from the cylinders to the draw bar, though it should be stated that Stephenson's system of intermediate crank shaft, for reasons of economy and simplicity, has been repeated. At the present date it may be said that experience has taught, and sound practical sense does teach, that the locomotive engine should be so constructed as to have the boiler independent of all the working parts of the steam engine proper, and free from any strains arising either from the work of traction or from concussions, all of which should be borne by the frame and the other parts of the carriage alone, while to the boiler is consigned the duty of generating the steam required for the performance of the work. The boiler, in fact, should simply rest upon the carriage, upon which also should be fixed the other parts of the engine in such manner that it still might be able to perform its work, if it were possible to supply it with steam after removal of the boiler. This condition has first been realised in a satisfactory manner by Mr. Allan, of the Scottish Central Railway, in his outside cylinder engines, as illustrated by diagram Fig. 8.

It is somewhat strange that, notwithstanding the above law has been well established by the experience of more than 25 years, not only in locomotive engineering, but in steam engineering generally, it is strange that the practice of stopping the inside frame in front of the fire-box, and of pulling from the latter through the boiler, should still be persisted in by some engineers,—as for instance by Mr. Sturrock, of the Great Northern, and by Mr. Kirtley, of the Midland Railway, whose modes of connection are illustrated generally by diagram Fig. 9, where the boiler is carried on the outside frame by means of ponderous wrought iron brackets which,

despite all improvements in the means of fastening them, never are tight. Various other systems of connection are illustrated in the sheet of diagrams, plate No. 245, with a view more especially to enable the reader to become thoroughly acquainted with the history of this portion of the subject, and as the systems already commented upon represent the chief types to be met with in modern practice, little further need be said, unless it be that Allan's system of outside cylinder engine is frequently simplified by the omission of the outside frame, at the unavoidable sacrifice of the wide carrying base. As for the engines with bogie frames, illustrated by Fig. 10, these should be but little required upon the well constructed permanent way, with easy curves, such as they are found in this country.

In America, however, where the roads are not really intended to be permanent, and where, besides, they are subject to the deteriorating influence of hard frosts, great falls of snow and sudden thaws, the bogie is found indispensible, its use is also beneficial in some mountainous districts in various parts of the continent, where sharp curves cannot be avoided.

Passing now to the consideration of constructive details of the frame, we find that Bury made them of bar iron, and in the earlier designs he generally bolted them together; later, however, he welded them together into one solid mass, as illustrated in the accompanying diagram.

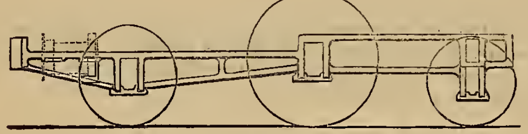


Fig. 1.

This made a very stiff and excellent piece of work, but as it is very expensive, and besides does not offer the same facilities for attachments and connections as the plate frames, is is now generally superseded by the latter. These are almost invariably made of rolled iron from 12 to 15in. deep over the axle forks and in the main body, and from 1in. to $1\frac{1}{4}$in. thick; they are usually welded in two points of their length, and though some engineers have, of late, introduced the practice of making them of one solid plate throughout, the former method is still preferred by the best makers, as well as by many locomotive superintendents of high standing, because it is less expensive, and may even be better relied upon when the plates used are of a good quality of iron, since it frequently happens that rolled plates of that thickness, and of 25ft. in length, by 2ft. 6in. deep, are not sound in the body. Outside frames are very often made of a balk of pitch pine from 10 to 12in. deep, by $3\frac{1}{2}$in. thick, and lined with two thin plates varying from $\frac{7}{16}$ to $\frac{1}{2}$in. in thickness. This method, however, has the disadvantage of providing a perishable frame, on account of the great liability of the timber to be destroyed by slow decomposition, a phenomenon which generally occurs where it is in contact with iron. On that ground we should prefer to see the outside frame made of a single plate, and which, when required, could be so stiffened, laterally, by means of cross stays binding it with the inside frame, as to render it fit for any duty which it may have to perform, without making it too heavy. Transversely the longitudinal frames are bound into one firm structure by means of vertical cross stays of from $\frac{3}{4}$ to $\frac{7}{8}$in. thick, both in front and at the back of the engine, as well as in its mid length, this latter stay being at the same time made to carry the slide bars, and in many cases portions of the link motion; at the back the frames are bound also by the draw box, made of two plates varying from $\frac{5}{16}$ to $\frac{7}{16}$in. in thickness, of which the upper one generally answers as the fireman's platform, or foot plate, and which are united by means of vertical webs in the manner of a cellular girder. In the case of outside cylinder engines, the transverse frame connections in the immediate vicinity of the cylinders must be very strong, and should in every way offer all the rigidity of a box girder, in order to prevent the frames from being disturbed by the great side strains, occasioned by the external position of the cylinders. Convenient platforms made of $\frac{5}{16}$in. plates are also provided along both sides of the engine, to enable the driver to reach all the working parts, for the purposes of inspection and of lubrication while the engine is in progress upon the road. The connection of all these parts is usually effected by means of strong angle iron and rivets; sometimes, however, instead of using angle iron the vertical cross stays are flanged, and in that case require to be made of the best quality of Yorkshire iron. As the height of the platform measured, from the level of the rails, seldom exceeds 4ft., the driving wheels generally cut through them, and the projecting portion of the wheels is incased within a light iron box, known as the splasher, which in its design is generally more or less ornamental, according to the taste of the designing engineer, and which may certainly be made to add greatly to the artistic beauty of the engine.

In order to make our subject as complete as possible, we ought perhaps cast a rapid glance at the various minor parts of the engine with which it must be supplied in order to be in that state of completeness which enables the driver to have a thorough control over it when it is at work, and which enables the engine itself to perform all the duties which may be required of it. As the construction of these parts, however, presents no other features of interest but such as are of daily occurrence in mechanical engineering, it will be sufficient to give—more especially for the information of the uninitiated—a cursory description of each individual contrivance forming an integral part of the engine.

Beginning with the boiler, we first notice that the fire-box is provided with an ash-pan, fitted tight to its underside, and which is supplied at the front, and sometimes at the back, with air tight dampers worked by means of levers and handles from the foot-plate which enable the driver to regulate the quantity of air to be admitted for combustion, whereby he has a thorough control over the evaporative capabilities of the boiler. The ash-pan is generally formed of plates $\frac{3}{8}$in. thick, rivetted together by means of angle iron; some attempts have been made to convert into useful effect the heat contained in the ashes, as well as the heat of radiation from the furnace, by making the ash-pan bottom of a cellular structure, and connecting it with the water spaces of the fire-box by means of pipes. The amount of heat lost, as above stated, however, has been greatly over estimated, and the result obtained has been actually *nil*, while the difficulties of construction of the machine have been thereby greatly increased. The fire-box is further provided with a glass guage, by means of which the driver can at all times ascertain the height of water in the boiler, and in order to enable him to read it at night, a lamp is placed close to the glass guage. As a measure of safety also, there are two or three guage cocks placed at different levels to enable the driver to ascertain the height of the water, should the glass guage break, or fail through obstructions to register the water level. One or two differently toned whistles are also placed within easy reach of the driver to enable him to give various signals.

Of late years it has become almost an universal practice to supply the boiler with a scum cock, by means of which the upper layers of the water may be drawn off, and along with them those impurities which float upon its surface. This has been found very beneficial in diminishing the evil of priming. A separate cock also is supplied for the purpose of warming the feed-water by means of a jet of steam directed into the tender through the feed pipes, and an approved pressure-guage is placed within close eyesight of the driver, and has the advantage of enabling him to regulate the intensity of his fire to keep the steam at the required tension. In order to protect the driver against those inclemencies of the weather which might greatly hinder him in the performance of his arduous duties by preventing him seeing ahead, a weather board, provided with glasses, is placed close to the back of the firebox, behind which he finds shelter against head winds and rains. In countries subject to great extremes of heat and cold the driver is still better protected by a complete enclosure, both at the sides and at the front, roofed over to form a little hut, generally known as the "cab," and, though this provision slightly affects the architectural features of the engines, we do not know of any valid reason why this boon should not be granted to the driver in this country. Convenient footsteps are also placed in close proximity to the footplate, which, in the absence of the "cab," is fenced in all round and provided with proper handrails.

The engine is relieved of the gases of combustion and of the steam that has performed its work, through a chimney placed upon the smoke box, and the height of which should not exceed 15 feet, measured from the level of the rails, for the purpose of clearance when passing underneath bridges or through tunnels. Mr. Clark mentions that a length of chim-

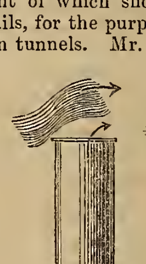


Fig. 3.

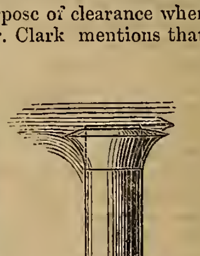


Fig. 2.

ney-proper, equal to about four times its diameter, is likely to develope the best action of the blast. That probability, however, rests upon no better foundation than Mr. Clark's own belief, and in practice no such rule is ever adopted; but the length generally is decided upon by considerations of æsthetics, subject to the limit we have above given, rather than by considerations of a proper action of the blast. With regard to its area, the same author thinks that it should be $\frac{1}{15}$th, that of the fire grate. We believe, however, that among the greater number of locomotive engineers the rule is to make its diameter either nearly or exactly equal to the diameter of the cylinders; and no doubt there is good ground to establish

a certain relation between the areas of the cylinders and of the chimney, when it is remembered that the former is governed by the heating surface, and indirectly, therefore, by the grate area. The majority of engineers ornament the top of the chimney with a cap piece, varying in shape according to taste, but Mr. Sinclair prefers to leave it a plain finish, as being more beneficial to the action of the draught; the accompanying sketches (Figs. 2 and 3) plainly illustrate the effects of head winds upon the draught as verified by all experience on the motion of fluids and shows most conclusively that Mr. Sinclair's practice is to be preferred. With reference to the draught, Mr. Clark also lays down a very doubtful rule as to the area of the blast orifice, which he thinks may vary from $\frac{1}{60}$th to $\frac{1}{90}$th of the grate area, whereas in practice it is always ruled by the area of the cylinders, being generally made a little less than the area of the steam ports or about $\frac{1}{13}$th that of the piston.

In order to relieve the cylinders of the water which would accumulate in them through condensation of steam they are generally provided at each end in the lowest portion of their circumference with small cocks worked, by means of a system of levers and rods, from the foot plate; these are known as the mud-cocks, and in designing an engine the necessity of making provision for these secondary wants has often been more troublesome than any of the vital questions of the general problem, for the simple reason that the whole of this very complex machine has to be confined within the narrow space of about four feet.

Close to the front, the engine is provided with strong vertical bars known as the life guards, reaching down to within two inches of the rails for the purpose of clearing the latter of any obstructions which either accidentally or maliciously may have been placed thereon; and in the case of heavy falls of snow, besoms are attached to them in order to sweep the rails; this provision is of great importance in most northerly climates and in some mountainous countries on the Continent, where heavy falls of snow are of frequent occurrence. Capacious sand-boxes are placed on each side of the engine provided with pipes reaching down to within close proximity of the rails and as near to the front of the driving wheel as possible, through which the driver may strew sand upon the rails when these are slippery, to cause the wheels to bite—a want which is generally felt at starting. To the immediate front of the engine a strong beam made of oak or teak, and known as the buffer-plank, stretches across from frame to frame, to which it is securely bolted; it varies from 14in. to 16in. in depth, and from 5in. to 6in. in thickness, and in width it covers the extreme points of the carriage measured over all. To this plank are bolted two buffers in such manner as to correspond with those on the ordinary carriages upon the line, and those generally used are De Bergue's india-rubber, or Brown's spiral spring buffers; a strong drawbolt provided with shackle, chain, and hook is also fixed to it, in order to enable the engine to pull any required load whilst running backward.

Fig. 4.

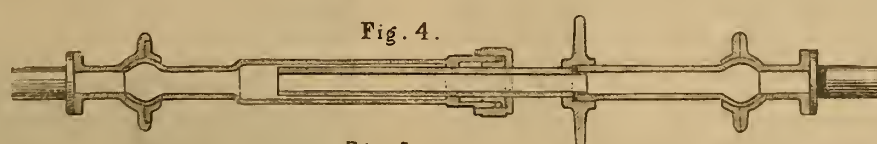
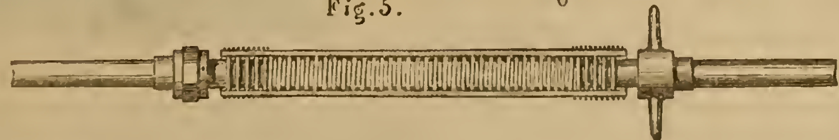


Fig. 5.



Finally to protect the boiler as much as possible against loss of heat from contact with the atmosphere, it is usually covered with a layer of felt all round the circumference of the barrel, and upon the fire-box as far down as the platforms; this layer of felt is lagged over with inch pine, and the whole covered over with thin sheet iron, No. 16 wire guage, held in its place by means of hoops or straps. In the corners of the fire-box this clothing is made complete by means of ornamental covers made of brass or of thin iron, so arranged as to hide the lagging; the steam dome is protected by means of an ornamental covering made of brass or sheet iron, and the safety valves are covered with an ornamental funnel of the same material, and sufficiently high to prevent the steam, as it escapes, from inconveniencing the driver. Those portions of the clothing which are made of brass are generally polished bright, and the parts of the engine exposed to view are covered with several coats of paint and varnish, of varying shades, according to the taste of the designing engineer.

So far we have confined our investigations to the engine alone; but as the tender is an inseparable adjunct to the former, except in those engines which, upon short lines of railways, are made to carry their own supply of water and fuel, we shall not have completed our study unless we give a short description of this faithful help-mate of the locomotive engine.

Generally speaking, the tender is a simple carriage, upon which is placed a tank, capable of carrying the requisite supply of water and fuel for a given length of journey, and in construction, this carriage is very similar to that of the engine, though, being subject only to the strain resulting from the transmission of a fair pull, and from carrying a dead weight, it may be proportionately lighter in the frame. This latter is sometimes made of four longitudinal plates of rolled iron, arranged in pairs at each side of the tender, the one outside the wheels, provided with the axle box girders and horn blocks, from 10 to 12in. deep in the body, by $\frac{3}{4}$in. thick, the other placed inside the wheels, being a plain stretcher $\frac{1}{2}$in. thick, and of the same depth as the outside one; sometimes this outside frame-proper is made of a baulk of timber from 3 to $3\frac{1}{2}$in. thick, lined with $\frac{7}{16}$in. plates of rolled iron similar to that already described when treating of the engine frame, and with which it is usually made to match. Transversely the longitudinal frames are connected by means of vertical stays made also of rolled plates, well stiffened by means of angle irons and horizontal gusset plates; at the front, and sometimes at the back, strong draw boxes, somewhat similar to that on the engine, also answer as transverse frame connections, the whole forming a rigid structure capable of transmitting the horizontal strain without the assistance of the tank, which in reality should rest freely upon the frame. In some cases the draw-box at the back is superseded by a buffer plank, similar to that at the front of the engine, and to which, when so applied, are attached the draw hook, and the safety chains, as well as the buffers. In order to ensure the steadiness of both engine and tender upon the rails, and to protect also the feed pipe connections from undue strains, the engine and tender are kept taut by means of a strong transverse spring resting horizontally in the draw-box, against this spring two small buffers, sliding horizontally in guides fastened to the box, are made to butt, and by the elastic force of the spring are constantly pressed against the back of the engine.

Some engineers prefer to make the tender frame entirely of wood, though it is difficult to ascertain a valid reason for this preference, since the cost of a wooden frame, as generally made, is very nearly if not quite, equal to an iron one, while it does not offer the same guarantees of strength and durability as the latter. To complete our remarks on the carriage, we should state that the wheels, the axles and the axle-boxes are, in construction, exactly similar to those we have described when treating of the Engine.

A powerful break is provided, by means of which the driver is enabled to accelerate the stoppage of the train when approaching a station, or in cases of emergency. It is worked from the foot plate by a hand wheel and screw, communicating an angular motion to a shaft with short levers forged or keyed upon it, and to these are attached the tension rods, by means of which the break blocks,—which generally pivot upon a centre fixed upon the frames,—are pulled against the wheels; the break is generally so constructed as to act upon all the wheels, and sometimes it is made to grasp the wheels on both sides, to prevent undue strain upon the axles.

Tenders with a capacity of from 800 to 1100 gallons of water have two pairs of wheels only, and generally do not exceed 16ft. 6in. in length measured over all; those of greater capacity are carried upon three pairs of wheels, and may reach a length of 20ft.

The tanks are constructed in different shapes, but that most prevalent is the one which in plan assumes the shape of a horse-shoe, the water being contained in that portion which forms the horse-shoe, and the fuel being stowed in the open space between the two legs. Sometimes it is made in the shape of a plain square box, rather shallow, with its sides projecting above the top of the tank-proper, upon which the fuel is stowed; this method is adopted with a view evidently of keeping the centre of gravity low. Sometimes, also, in longitudinal section, it assumes the shape of a trapezium, the front wall of the tank sloping up backwards in an easy curve, while the side walls are carried up square, and the fuel is stowed in the space thus left free. In each case the tank is made of rolled plates, varying from $\frac{3}{16}$ to $\frac{1}{4}$in. in thickness, jointed by means of 2in. angle irons and $\frac{5}{8}$in. rivets; an ornamental coping is carried all round the top of the tank, which further adds to the fuel space.

The communication between the engine and the tank is maintained by means of continuous flexible pipes on each side of the engine, and various contrivances have been adopted to enable these junctions to adapt themselves to the shifting requirements of the engine upon the road, without interrupting the communication. The one formerly in general use, which is known as the telescope pipe, is illustrated by the accompanying woodcut (Fig. 4), and consists of two distinct portions of pipes assembled by means of ball joints, the one portion being enlarged on the greater part of its length to such an ex-

tent as to enable it to receive and to allow freely to slide inside of it a hollow plunger equal in diameter to the feed pipe, and connected to the other ball joint by means of a screw coupling; the joint between this plunger pipe and the barrel being made good by means of a stuffing-box. This contrivance, which answers its purpose very well, requires to be made of brass, and being of difficult workmanship, is for these reasons very expensive. Soon after the discovery of the properties of vulcanized india rubber and its introduction into various useful arts, the just described contrivance was replaced by the much simpler, and equally effective one illustrated by Fig. 5, which consists of two short couplings ribbed upon their internal circumference, and connected by means of an india rubber hose, kept stiff by means of a wire coil placed inside of it.

The capacity of the tank must be determined by the nature and requirements of the traffic for which the engine is intended; according to Mr. Ramsbottom, a maximum volume of 28 gallons of water per mile, are required for a heavy mail train upon a heavy road; and at this rate of consumption, a tender baving a capacity of 800 gallons would be required for a journey of 30 miles, and a tender of 2000 gallons for a journey of 70 miles witbout stoppage; these are the two extreme limits of tender capacity to be met with upon English lines of railway, and tbe space allotted for fuel is about one-fourth that for water.

Of late, however, tbe requirements of the Irish mail service, compelled Mr. Ramsbottom to perform the journey between Chester and Holybead or a distance of 84¾ miles in 2 hours and 5 minutes, and necessitated tbe increase of the size of tender tanks from 2000 to 2400 gallons, or else required the taking of water at some convenient point upon the road, either by stopping or by picking it up whilst running. The first method of solving the problem involved an objectionable increase of weight in the tender, resulting in a loss of locomotive power equal to that required by an additional carriage to the train, while a stoppage entailed a loss of time which could not well be spared upon that heavy road in bad weather. Mr. Ramsbottom, therefore, conceived the idea of picking up the water wbilst running, by dipping a pipe into a trough laid longitudinally between the rails, the dip pipe being curved forward at its lower end in the direction of motion; by tbis contrivance it was expected that the water would rise in the pipe to a height nearly equal to the head of of water, which would produce a velocity of outflow equal to the speed of the train, and he soon reduced his idea into a practical shape by means of tbe apparatus illustrated in Figs. 1 to 5 (plate 246), which is so simple that it scarcely needs to be explained. It consists of a cast-iron trough 18in. wide by 6in. deep, laid upon the sleepers between tbe rails, in such a manner that when it is full, the level of the water shall be 2in. above the level of the rails, as shown in Figs. 1 and 2; and furtber, it consists of a scoop or dip-pipe for raising the water, made of brass and having an orifice 10in. wide by 2in. high; this scoop is carried upon a transverse centre, and when not in use it is tilted up by a balance weigbt, as sbown in Figs. 3 and 4, and in order to dip it into the water, it is depressed by means of a handle worked from the foot plate which requires to be held by the driver as long as the scoop must be kept down; when it is lowered, its bottom edge is level exactly with the rails, consequently dipping 2in. into the water, and the limit of depression is fixed by means of two set screws which answer as a stop, and which afford also the means of adjustment wben the axle-box brasses and the wbeel tyres are worn down.

In order to diminish the velocity of discharge of the water into the tender, the delivery pipe is enlarged gradually from the bottom to the top in such manner that the area at the top be 10 times that at tbe bottom, and consequently the velocity of discharge is one-tenth only that of tbe train; if, therefore, the water be picked up at a speed of 50 miles per hour, it will be discharged into the tender at a speed of 5 miles per hour or 7ft. per econd, which is that due to a head of about 1ft.

One of the most important points, and by no means the least difficult in the practical application of this apparatus, was, at first, to provide a sure and ready means of lowering tbe scoop into the trough; this problem, however, has been solved in a most satisfactory manner, rendering that part of the operation of taking water quite independent of the thoughtfulness or skill of the driver, viz., by simply lowering tbe level of the rails with an easy slope in the whole length of the trougb, as shown in Fig. 5.

The trough laid down on the Holyhead line is about a quarter of a mile long, cast in lengths of about 6ft., and made water tight, and flexible at the joints by the interposition of a round strip of india rubber. The maximum quantity of water which may be raised, is equal to the area of the scoop multiplied by the length of the trough, and in the case instanced amounts to 1150 gallons; the results obtained in practice are as follows:—

at 15 miles	0	gallons.
at 22 do.	1060	do.
at 33 do.	1080	do.
at 41 do.	1150	do.
at 50 do.	1070	do.

showing that the apparatus may safely be relied upon at any speed upwards of 20 miles.

This is unquestionably one of the most interesting applications of a principle in bydraulics known to us since the days of Toricelli, and which will probably become very general in the railway practice of thinly-populated countries abounding with clear water courses; it recommends itself at once also on the score of economy since it saves both the working expense of raising the water into an elevated tank, and the first cost of the pumping machinery. Independently of tbis it is deserving of special notice, on account of its ingenuity.

(*To be continued.*)

SUBMARINE TELEGRAPHY.

Captain Selwyn, R.N. proposes to employ an apparatus for paying out electric telegraph cables, which he has described as follows:—

One, two, or more cylinders, if preferred, of plate iron, ½in. thick, are constructed to carry such portion or portions of the cable to be laid as may be thought desirable; but as it is most convenient to make the necessary calculations on some known basis, the Atlantic cable is first taken as an illustration.

That cable weighs one ton per mile in air. In water 14 cwt. Its diameter is ⅝in. Its cost about £100 per mile. The distance laid is 2022 miles, and the distance between Valentia, Ireland, and Trinity Bay, Newfoundland, is 1650 nautical miles, 3000 miles will be taken as necessary in these calculations.

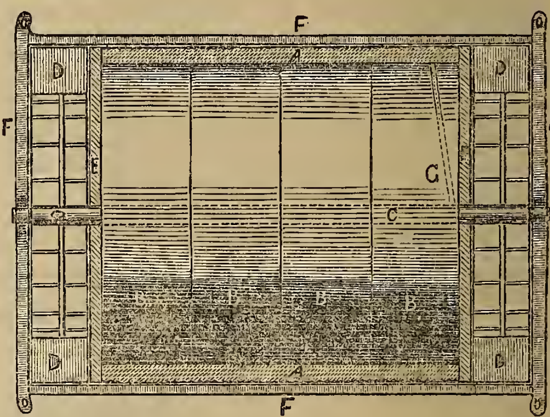


Fig. 1.

The size of cylinder. with paddle wbeels attached, which will carry 1500 tons, or half the cable, at less than half immersion,—say about 20ft. draught,—is 60ft. long and 50ft. diameter, this gives a tonnage of 3366. The cylinder being formed of ½in. iron plate throughout with double ends, 3 partitions, wheels, frame and stays, rivets, angle irons, &c., the rough estimate of weight is 300 tons, which at £20 per ton (to allow for manufacturer's profit), will be £6000 total cost.

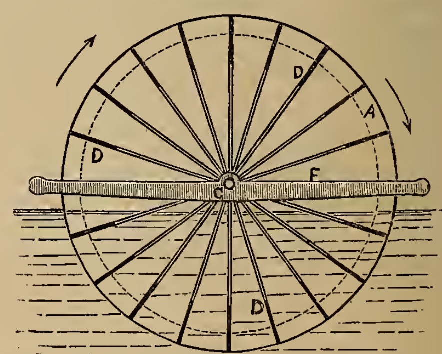


Fig. 2.

But the present light cables may be carried at considerably less expense, if, indeed, one or two thousand pounds be considered an object in carrying a cable, wbose cost must be reckoned by hundreds of thousands, and in which a difference of 6d. per lb. in the expense of manufacturing the gutta-percha would more than cover the whole of the cost of laying by these means, tbat difference (as 400lb. of gutta-percha are used in each mile, of 3000 miles) being equal to £30,000.

In the accompanying diagrams, Fig. 1 represents a horizontal sectional plan of the cylinder, &c., A being the layers of cable coiled round the

cylinder B, which is formed in four compartments; C is the hollow axle; D D the paddles at each end of the cylinder; E E the ends of the cylinder; F is the external frame by means of which the apparatus is towed; G is the tube through which the inner end of the cable is led. Figure 2 is an end view of the apparatus.

The draught of water of such a cylinder will be about 6ft. when light, and it would in that state take a weight of 5 tons at 10ft. from the centre, to deflect it one quarter of a degree from the horizontal. With reference to the objection advanced on account of the resistance to towing, which will be considerable when not laying cable, Capt. Selwyn argues that the drawback on this account is not of so serious a character as might be anticipated; one steamer, it is well known, can tow another of her own size at a very small diminution of her speed.

Thus, if 800 horse-power propel a ship 10 knots, then two ships of equal size will be propelled by the same power acting in one of them, not 5 knots, but 8 nearly.*

If, during the laying, the cable should by any accident be broken, means are provided by which the cable may be caught and held, even miles astern of the ship, until she can go back, and, picking it up, make a splice, and proceed anew. If the cylinder be cast off, or the tow ropes broken, so soon as any strain is felt upon the cable by the drift to leeward of the cylinder, the result will be, that the cylinder will turn round and "ride to" the cable, veering slowly in answer to the strain, but resisting any rapid pulling off of cable by the beating of the paddles on the water,

Arrangements are made for reefing or expanding the paddles during revolution, so as to regulate the amount of slack, or tightness, of cable as desired. Also for testing through the cable electrically during the coiling on, or laying, by passing the end of the cable, which is first coiled on, out through one of the axles; there it is allowed to turn freely, in contact with a spring, or dipping into a cup of mercury, as preferred. The details of the calculations of weight and cost of cylinder for carrying a submarine telegraphic cable, such as the Atlantic, are thus stated by Capt. Selwyn:—

	Ton.	cwt.	qr.
Weight of cable in air per mile	1	0	0
,, in water	0	14	0
Diameter	$\frac{5}{8}$ inch.		
Length	3000 miles.		

The cable to be carried thus. Two cylinders are to be built of $\frac{1}{2}$in. iron, each 60ft. long by 50ft. diameter, with double ends 2ft. apart, and paddle wheels attached, the ends to have a diameter of 56ft., and the whole to be surrounded by a frame, in which the axles revolve. The tonnage of each of these will be as follows:—

Area of 50ft. = 196,350 × 60 length = 11781000 ÷ 35 (cubic ft. in one ton) = 3366 tons burden.

Ends:—area of 56ft. = 176 × 2ft. wide = 352 × 2in. = 704 ÷ 35 = 20 tons.

Thus we get a total supporting power of 3,386 tons. The weight of cable to be carried, at, say, one-third immersion, will be thus $\frac{1}{3}$ of 1500 = 500, therefore we have 1000 tons plus (500 × 14 cwt.) 350 tons, or 1350 tons weight of cable. The gross tonnage 3386 − 1350 cwt. of cable = 2036; 2036 − 1350 = 685 tons less than half immersion.

Now the weight of the cylinder will be about 300 tons, this also must be taken into consideration; 686 tons — 300 tons, leaves 386 tons less than half-immersion as the datum for calculating draught of water—

60 × 50 = 3000 cubic feet ÷ 35 (number of cubic feet in one ton) = 85 tons for the first foot.

Now roughly dividing 380 by 85 gives about 4ft. 6in. as the draught corresponding to 386 tons. This means 4ft. 6in. less than half-immersion, or 20ft. 6in. as the load draught.

The calculations of weight are as follows:—

BARREL.

Length of Cylinder.		Circumference of 50ft. diameter.			No. of lbs. in 1 sq. foot.		Weight of Barrel. lbs.
60 ft.	×	157,080	=	94,248	× 20	=	188,496

3 PARTITIONS.

	Area						Weight of Partitions. lbs.
50 ft.	= 196,350	×	3	= 589,050	× 20	=	117,810

4 ENDS, 56 FEET DIAMETER.

	Area.						Weight of Ends. lbs.
56 ft.	= 246,301	× 4	= 985,204	×	20	=	197,040
Assumed weight of frame, wheels, stays, rivets, angle iron, cuttings, &c., &c., 80 tons, or						=	179,200
						Total...	682,546

$$\frac{682{,}546}{2240} = 304\tfrac{1}{2} \text{ tons.}$$

Total weight of cylinders and attachments 304 tons, multiplied by £20 per ton, to get probable cost, gives £6080.

Next, there is the calculation of the thickness of cable when reeled on cylinder; the total number of miles in one layer; and the number of layers on the cylinder when 1500 miles are coiled on.

Diameter of cable, five-eighths of an inch; length, 1500 miles; mean diameter of cylinder and cable, 52ft.: length of barrel, 60ft.

Then—

Circumference of 52 feet = 163·36

Number of turns of five-eighths of an inch in 60ft. 1153·4 × 163·36 = 188409·424, and

$$\frac{188409{\cdot}424}{6082^*} = 30{\cdot}9, \text{ and}$$

$$\frac{1500{\cdot}}{30{\cdot}9} = 48{\cdot}5 \text{ layers.}$$

48·5 × 5 ÷ 8 = 2ft. 6in. thickness of 1500 miles of cable when reeled on.

The cylinder should, after launching, be brought to the nearest wharf which has the required depth of water for its flotation when loaded. Being moored off, it may either be set in motion by the tide or current, or if in dock, the paddle floats being taken off, or reefed in, it may be caused to revolve by bands from portable steam engines on the wharf, and the cable will be coiled on as cotton on a reel. Testing with the cable *in water* can be carried on during the whole of this operation, the inner end having (before beginning the coiling) been passed out through one of the axle-ends. The next thing will be to replace the paddle floats, if these have been reefed or taken off; and now with the end secured, the cylinder may be taken in tow for its destination. The paddle-wheels will cause revolution, and diminish, by so much, the retarding effects of friction.

Having arrived at the point in mid-ocean or elsewhere, from which the operation of laying is to commence, the ends of the cable, of which 1500 miles will be on each of the two cylinders, are joined up, and the towing vessels start for their respective shores.

Any speed judged desirable, or which the towing vessel is able to accomplish, may be kept up regularly and without danger. A speed of 10 knots would cause the cylinder to revolve at the rate of about six turns per minute, or the outside of the cylinder would have speed of 1013·6ft. in a minute, which, for a paddle-wheel, is not excessive, the *Great Eastern* having considerably more. Supposing each ship to have gradually reached even this speed, and that the curve of cable between them were 100 miles, it is clear that any surge caused by a wave would be felt, first by the ship, next by the cylinder tow ropes, which will have an elasticity due to the catenary curve in which they must hang, and then by the cylinder; and last of all, and but slightly, by the cable, which is at no time absolutely checked in its unwinding.

When the pull comes on the cylinder, the immediate result is to bring a greater turning force on the paddle floats, and thereby to give off more cable than the 10-knot speed required.

Further, to obviate any possible strain to the cable, there is a provision as has before been stated, for expanding, or reefing, the paddle floats while towing, so that the diameter of the wheels, which govern the revolutions, can be increased or diminished, relatively to the barrel of the cylinder, the result being, that as much, or as little, slack is laid as may be proper.

While there is great depth of water, and consequently great suspended weight of cable, the wheels will be deeply immersed, and great resistance will be opposed to any more cable being dragged off, than the percentage of slack which has been decided on. If the depth alters, the resistance immediately increases or diminishes with it, by the weight of cable hanging under being also altered, and as the cable goes off, the cylinder rises out of the water, opposes less resistance to towing, and has fewer floats immersed. As the shore is approached, the draught of water will have lessened, so that the cylinder itself may, if requisite, be towed into the harbour, instead of a second shifting into boats, which may easily be a cause of damage.

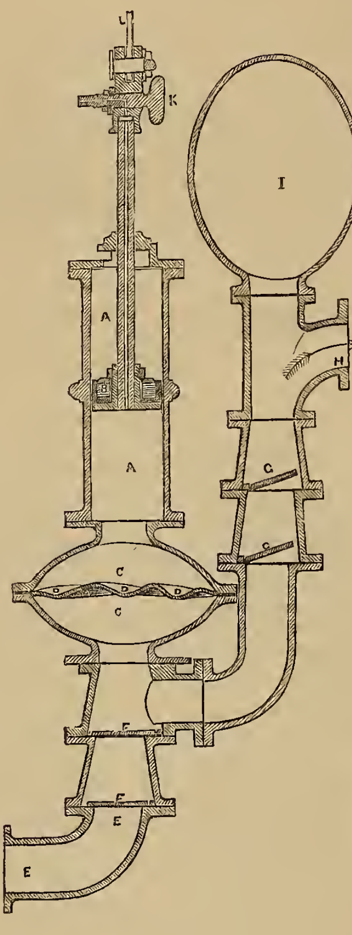
* Capt. Selwyn states as an illustration of steam towing, that Capt. Ericsson's small screw vessel, of 45ft. length, 8ft. beam, and drawing 2ft. 3in. of water, towed the American ship *Toronto*, of 630 tons burthen, on the Thames, 28th May, 1837, at the rate of $4\frac{1}{2}$ knots per hour against tide.

* No. of feet in one nautical mile.

WALKER'S DIAPHRAGM MUD-FORCING PUMP.

This pump has been specially designed to obviate the objections which have hitherto existed against the employment of any contrivances in which water, highly charged with solid matter, is allowed access to the working barrel of the pump.

It will be seen from the accompanying illustration, that in the pump under notice the thick muddy water never passes above the vulcanized india rubber diaphragm D D D, which oscillates in the chamber C, with the piston or plunger B. A, being the working barrel or cylinder; E, the suction pipe; F F, suction valves; G G, delivery valves; H, delivery pipe; I, air chamber; K, tap to let out the air from, and water into the cylinder when first starting the pump; L is the connecting rod.



Double valves are provided both above and below the diaphragm, so that in case of one valve being fouled, the action of the pump may still be carried on without interruption.

This pump is now being tried at Birmingham, where the whole sewage of the town is collected in large ponds at Saltley, and where the deposit has hitherto been a source of great expense. Pumps of this description may probably be found a valuable substitution for the filth-hoists proposed for the outfall tanks of the Metropolitan Board of Works.

The employment of this pump which will effectually distribute liquids, however copiously they may be charged with solid matter, is well worth the consideration of all public bodies having to deal with large quantities of sewage.

THE ENGINEERS OF THE ROYAL NAVY.

We have on frequent occasions endeavoured to make out a case on behalf of the Engineers of the Royal Navy, and the great and urgent necessity which has so long existed for an improvement in the *status*, the pay, and treatment of this most valuable body of naval officers.

Our attention has been drawn to the printed document prepared for, and sent to the members of the Committee of the House of Commons, on the promotion and retirement of naval officers; and as we consider the subject one of national importance, we give a copy of the document *in extenso.*

"Royal Naval Engineers.

"The following is a statement of the disabilities under which the Royal Naval Engineers consider they labour, and of what they deem necessary to place them on a more satisfactory footing than they at present occupy in Her Majesty's Service:—

"1st. That the pay of Naval Engineers is insufficient, and that an increase of pay in their case would be a measure not only of justice but of wise economy. Of justice, because with their present rates of pay they are unable to maintain the position their rank in the Service demands, and also because the other officers of the civil branch, of equal rank, are better paid for services which the engineers consider are neither more responsible or arduous than their own. And of a wise economy, because by increasing the pay, the Admiralty would then be able to secure the best of the engineering talent of the country for the Royal Navy, and as the duties and responsibilities of the engineers are daily increasing in consequence of the various additions and alterations to the mechanical arrangements of ships generally, so also is the necessity for increased skill and intelligence on the part of the Engineers.

"2nd. That Naval Engineers be permitted to retire at an earlier age than at present allowed, with an addition to the rate of half-pay to which they may be entitled. Te request for retirement is submitted on the consideration, that from the peculiar and trying nature of an engineer's duties, his constitution receives injury, and as a rule it will be found he is physically incapacitated at an earlier age than 60 years, for the active discharge of the duties of a Chief Engineer at sea.

"3rd. That the accommodation for Assistant Engineers, is—as a rule—positively bad; that it would be conducive to the good of the Service if they were made Gun-room Officers; that the senior Assistant in all ships should have a cabin, and that when an Assistant Engineer is in charge, he mess in the Ward-room. The accommodation generally is so bad, that we believe it to be one great cause of disease, and were the Assistant Engineers made Gun-room Officers, we believe it would tend not only to improve those already in the service, but be the means of inducing a superior class of candidates to offer themselves for entry, as well as saving space in the ship. The peculiar duties devolving upon the Senior Assistant, make the want of a cabin more felt by him than by any of the others. Allowing the Assistant Engineer in charge of the machinery to mess in the Ward-room would be beneficial to the Service, by placing him in close communication with the other heads of departments in the ship, and materially strengthen his position in the execution of his duty.

"4th. That Assistant Engineers, after serving the prescribed period, and having passed either a provisional or other examination, receive the pay of the next higher class, that after becoming commissioned officers they be allowed a scale of half pay, and that all time served from date of entry count for full and half pay, their names also to appear in the Navy List on becoming commissioned officers. Under the present system the Assistant Engineer after serving the stipulated period, and passing his examination for a higher class, is kept waiting for his promotion, generally for a long and indefinite period, which we think ought not to be the case.

"5th. That the widows of engineers be granted ordinary pensions. They feel convinced that this measure is one of great moment to the junior branches of the class. The nature of an engineer's duties frequently impairing or destroying the health of the most robust, before they attain the position of Chief Engineer.

"6th. That a distinct rate of half-pay be granted to Inspectors of Machinery afloat, according to their rank, and that full and half-pay both of inspectors of machinery and chief engineers be allowed to increase at a proportionate rate for each year's full pay service, as the present system of requiring five years' service to be completed, for an increase of full and half pay, is productive of great hardship to those officers who from illness or inability to procure employment fall short (possibly by only a few months) of the required time, and thereby lose the advantage of their service during the remainder of the interval.

"7th. The Engineers of the Royal Navy, viewing with satisfaction the course pursued from time to time by their lordships in appointing Naval Engineers to fill vacancies in the various dockyards. trust the practice will be continued, as they are convinced such a course has been, and will be, productive of much good, and benefit the public service."

The claims advanced by the naval engineers, we have no hesitation in stating, are very moderate in their character, and we hope that, not only in common fairness, but for reasons of policy that now the question of naval improvement is occupying a very prominent share of public attention, that the claims of the engineers may meet with that consideration to which the importance of their position entitles them.

The fact is, it is a rather difficult matter for an outsider to comprehend the peculiar phases of naval life,—its distinctions and divisions,—yet, to rightly understand the wants of the Engineers as Naval Officers, these divisions and distinctions, should to a great extent be understood. Now we will believe it will be conceded that most questions involving class improvements are in a great measure, comparative, and Engineers in Her Majesty's navy have a right to compare their position and emoluments with those of the engineers of other governments, and with our own mercantile marine.

We will now briefly refer to the several clauses of the printed statement. The first states that the pay is "insufficient to maintain the position, which their rank," &c., and here perhaps a little consideration of naval rank may not be out of place. Of course, every individual in the Navy, as in the mercantile marine, holds a certain rank or position, supposed to follow from the nature and importance of his duties—but the great distinction of the naval service is in its division into military and civil branches. The first includes Admirals, Captains, Lieutenants, Masters, &c., the latter embraces Engineers, Surgeons, and Paymasters. The former are called Executives, the latter Civilians. The former aspire to command, and to a very great extent monopolise all the honours and rewards the naval service has to offer. The latter—at all events, the engineers—enter the service as a profession, in which at least a respectable livelihood ought to be obtained. The former are more particularly the class to which Lord Palmerston referred when he asserted in the House of Commons, "that the honour of holding a commission in the Navy was to be considered as a fair set off to an acknowledged smallness of pay." The civilian class, however, cannot accept that supposed honour as an equivalent for the hard cash which their labour and skill fairly entitles them to receive.

True the rank which Naval Engineers hold is little more than nominal, for it still leaves them—and, it is to be presumed, necessarily so—as the regulations state "in all such details and matters as relate to the service on which they are employed, subject to the authority of the executive officers of the military branch."

This nominal or relative rank, therefore, merely gives a certain standing in the ship, while it entails as a consequence an expensive style of messing and uniform.

Engineers, then, few of whom can be expected to possess private means, have a right to ask that their pay shall be such as to enable them to maintain their position, not in extravagance certainly, but fairly and honourably to pay their way, without running into embarrasment, in order to maintain an appearance while in commission, when too often a wife and family is left at home struggling through difficulty and debt, to make "both ends meet."

Again, "other officers of the *Civil* branch are better paid for services neither more responsible nor more arduous. We do not think the Engineers can be charged with presumption in making this comparative statement of the relative importance of the duties of the Civil Officers; for instance, however essential the duties of a surgeon may be, and however necessary the labours of a paymaster, we think it will be readily admitted that in a war ship especially, an Engineer is at least as indispensable as either of the preceding officers. Why then, we may well ask, are they so much better paid? The medical officer (and we should indeed be sorry if we were understood to imply that he is *too* well paid) receives 10*s.* per day the first day he joins the service, while the young engineer commences at 6*s.* The surgeon, on his promotion, which usually takes place in about seven or eight years from his entry into the navy, gets 15*s.* per day, while the Engineer, who seldom gets his promotion to chief in less than twelve or thirteen years, receives but 10*s.* 6*d.* per day. Nor is this injustice removed by length of service, as will be seen from a glance at the highest rates of pay to which each of the classes of civil officers can, under any circumstances, attain.

The pay of a Medical Inspector is £821 per annum, that of a first-class Paymaster is £600 per annum, while the highest pay of an Inspector of Machinery is but £401 per annum. These immense differences must appear the more striking when we consider the importance of the duties devolving upon an Inspector of Machinery of a fleet composed of say only a dozen of our modern line of battle ships, or iron frigates, and yet with all that responsibility his pay is some £200 per year less than that of a first-class Paymaster.

The next point in the printed statement, is that Engineers should be allowed to retire at an earlier age than 60 years. This seems to us a very reasonable request, when we consider the arduous nature of engine-room duties. An Engineer of 60 years of age, implies about 35 or 40 years of active service in all parts of the world, from the coast of Africa to the Arctic regions, and his chances of *enjoying* his half pay after that time are small indeed.

The third clause refers to the accommodation provided for Assistant Engineers. Now let us imagine a young Engineer, of good education and ability, of fair social position, and accustomed to the comforts of a good home, entering the service. His first night on ship-board is almost sufficient to sicken him. A hammock to sleep in, the open deck to undress upon, no partition, even of canvass, to screen him from the sights and sounds of stokers, marines, and sailors, he may well feel disgusted with his new career; yet so difficult is it to provide a remedy for this state of things, that it appears cabin accommodations is only asked for the senior assistant in all ships.

The necessity for making the junior Engineers, Gun-room officers is very great, not because Engineers are willing to admit that an entry into the Gun-room would be an elevation or an honour to themselves, but because while they mess by themselves, other officers in the ship are enabled, and in most instances do, treat them with neglect and indifference. Their rank is at all possible times ignored, and their being banished—as they are in the *Warrior* and *Black Prince*, and many other vessels—to the fore part of the ship, away from all contact with the other officers, is looked upon and urged as a proof that the rank which the Admiralty have given them is really only nominal, and was not intended to confer upon them such claims to considerate treatment, as it does in the case of the other junior officers.

On referring to the classes of junior Engineers and the officers in the Gun-room with whom they rank, it appears that the

Engineer ranks with	Sub-Lieutenant, Second Master, Assistant Paymaster.
Assistant Engineers, 1st & 2nd class, with	Midshipman, Master's Assistant, Naval Cadet, Clerk and Assistant Clerk.

Thus it will be seen that the Assistant Engineers rank with the seniors of the Gun-room Mess; so that, asking that they may be allowed to mess in the Gun-room, is not asking for a rise, but merely to prevent a continuance of that system of exclusiveness on the part of other officers which the present plan of a separate mess enables them to adopt, and seems partly to justify.

The request that the Engineer in charge of the machinery of a ship be allowed to mess in the Ward-room is, we consider, reasonable enough, seeing that he is virtually Chief Engineer of that ship, although his rank in the service may only be Engineer, or, perhaps, First-class Assistant.

The fourth clause needs some further explanation, and this is rendered rather more difficult through what appears to us to be a very absurd change in the titles of Assistant Engineers. Until about a year ago, all Engineers below the rank of Chief, were, rightly enough, called Assistant Engineers of the 1st, 2nd, and 3rd classes. Since then, however, the 3rd class has been abolished, and the titles of "Engineer," Assistant Engineer 1st Class, and Assistant Engineer 2nd Class take their place, but, whilst this alteration certainly produces a considerable amount of confusion when endeavouring to speak or write about Naval Engineers, it is not considered a "grievance." What *is* to be complained of, however, is, that when the young Engineer, who was told before he entered, that he had to serve three years in one grade, two years in another, and three years in a third, &c., has served these stipulated periods, he does not really get his promised promotion for months, and in some cases, we believe, as much as a couple of years pass. There are other officers, we believe, in the same predicament, but the grievance tells much more heavily on the Engineers, in consequence of the number of grades through which they are made to pass, and the number of examinations they have to undergo.

This is really a great grievance, and we have heard of some very excellent Assistants who are getting weary and disgusted with the service from this very cause.

We are informed that there are private and confidential reports sent quarterly from the Captains of H.M. ships to the Admiralty, as to the character and conduct of all officers, and the young Engineer who is kept waiting month after month for his "step" naturally suspects, that in spite of the "good" certificate he may hold, he has been injured in some way by a previous private and confidential report.

It is asked that "all time served from date on entry count for full and half pay." We cannot understand why the younger years of a man's life should be thrown away, and why, if any time at all which an engineer serves ought to be reckoned, the *whole* of it should not be taken into account. At present the engineer who enters the service at 21 years of age, and is lucky enough to arrive at the position of Chief Engineer at the age of 33 or 34, loses entirely at least eight years of his time. Medical officers, on the other hand, count their time from the moment they enter, and we think Engineers should also have that right extended to them. The request is also urged that when an Assistant becomes a commissioned officer he should be allowed a scale of half-pay.

Assistant Engineers are the only class of commissioned officers who are not allowed half-pay, which they consider is an invidious distinction, tending, with other things, to lower them in the estimation of other officers. They are allowed a scale of harbour pay; with the amount of which they do not so much complain, as of the compulsory attendance at one of the dockyards, which it enforces upon them. Other officers, after a three or four years absence, receive their half-pay and are thus able to visit their friends in various parts of the country, recruiting their health, and enjoying some of those social amenities to which, however, the engineer is expected to bid adieu when he enters Her Majesty's Navy, and when it is seen that the half-pay which is granted to an Assistant Surgeon—with whom only the engineer can fairly be compared—is greater even than that allowed to a Chief Engineer, the Assistant Engineer, with his harbour pay and dockyard attendance, has a right to complain.

"Their names also to appear on the Navy List, &c." Here again engineers are the only commissioned officers whose names do not appear on the official lists—published quarterly—and when it is known what frequent changes take place among the junior officers of ships on foreign stations, it is not surprising that the friends of an Assistant Engineer very frequently lose sight of him altogether for years, unless they happen to be in personal communication with him.

We need hardly say anything as to clause 5. It is self-evident, especially when the fact is considered that the average time it takes to arrive at the position of Chief Engineer is thirteen years, and that there must be many who can never arrive at that position at all.

Paragraph 6 is one of great importance, but except the first point, it comes under the old and most important head of pay. More pay is what it means, pay to increase annually instead of every five years, as at present. The first point, however, deserves some consideration; the Inspector of Machinery should, we think, be a distinct rank of itself, carrying with it distinct full and half-pay. At present, however, the Inspector of Machinery, after serving in his admittedly responsible position for any number of years, returns to the scale of half-pay to which he would have been entitled had he remained simply a Chief Engineer. This, were it not an injustice, would be ridiculous, and we think it certainly must be an oversight.

Clause 7, being merely an expression of satisfaction on the part of many engineers, we do not think we need further notice.

ABSTRACT OF ENGINEER'S LOG OF THE "GREAT EASTERN." SEVENTH VOYAGE FROM LIVERPOOL TO NEW YORK, MAY, 1863.

Date each day, ending at Noon.	Paddle Engines. Revolutions of Engines each day.	Paddle Engines. Average Revolutions per minute.	Paddle Engines. Average Pressure of Stm. in Engine-room.	Paddle Engines. Tons of Coal used each day.	Screw Engines. Revolutions of Engines each day.	Screw Engines. Average Revolutions per minute.	Screw Engines. Average Pressure of Stm. in Engine-room.	Screw Engines. Tons of Coal used each day.	Total quantity of Coal used each day.	Number of Knots run by Paddle Engines.	Number of Knots run by Screw Engines.	Distance run by Ship in Knots.	Latitude.	Longitude.	Course.	Barometer.	Observations on Rolling of Ship. Inclination to windw.	Inclination to leeward	No. of oscil. per min.
			lbs.	Tons			lbs.	Tons	Tons	K.	K.	K.				inches.	deg.	deg.	
May 16 ...	565	6·0	20	35	3,150	...	17½	50	85	17	19	17	...	...	Various.	...	...	...	...
May 17 ...	10,627	9·32	21	107	44,140	34·4	17½	136	243	251	279	150	51·42 N.	8·7 W.	S. 82·52 W.	...	...	...	...
May 18 ...	13,103	9·0	21	115	51,000	34·4	17½	164	279	335	367	282	57·7 N.	15·35 W.		30·10	...	...	...
May 19 ...	13,930	9·5	21	123	51,080	34·7	17½	167	290	346	366	306	50·41 N.	23·32 W.	S. 85·4 W.	30·04	...	...	...
May 20 ...	13,912	9·5	21	129	51,580	35·2	17½	167	296	344	371	303	49·30 N.	31·10 W.	S. 76·27 W.	30·04	...	...	...
May 21 ...	14,596	10 0	21	116	51,210	35·4	17½	177	293	362	376	284	48·17 N.	38·6 W.	S. 74·55 W.	29·09	...	...	...
May 22 ...	13,113	9·25	21	127	50,220	34·5	17½	176	303	335	362	304	46·11 N.	44·48 W.	S. 65·16 W.	29·06	...	...	...
May 23 ...	14,527	10·0	21	126	50,940	34·6	17½	176	302	365	365	312	43·39 N.	51·8 W.	S. ·62 W.	29·03	...	...	...
May 24 ...	13,430	9·0	21	121	51,930	35·34	17½	181	302	326	371	250	42·13 N.	57·32 W.	S. ·73 W.	29·40	...	...	...
May 25 ...	13,140	9·0	21	113	50,920	35·0	17½	177	290	326	371	298	39·47 N.	63·48 W.	S. ·82 W.	29·62	...	...	...
May 26 ...	13,519	9·3	21	115	53,190	36·5	17½	182	297	334	379	292	39 53 N.	68·20 W.	N. 88·49 W.	29·60	...	...	...
May 27 ...	12,485	9·4	21	118	47,470	36·0	17½	174	292	312	348	252	Steer	ing by the	land, various.	...	...	...	...
May 28 ...	2,091	8·0	21	20	8,070	31·0	17½	32	52	51	47	51	...	...	...	...	...	...	...
Total	149,038	9·35	21	1365	564,900	35·45	17½	1959	3324	3704	4021	3101	...	...	...	...	...	...	...

Actual time of steering 11 days 1 hour and 30 minutes; density of water in boilers, 1⅝; vacuum in paddle engines, 25; ditto in screw engines, 25; extreme diameter of paddle wheels, 50ft.; effective diameter, 48ft. = 150·79ft. each revolution; screw, 44ft. pitch; average distance run per hour, 11·7 knots; immersion on leaving Liverpool, 23ft. 11in forward; 26ft. 2in. aft.; immersion on arriving at New York, 21ft. 10in. forward; 23ft. 8in. aft.; slip of paddle wheel, 19·44 per cent.; ditto screw, 29·66 per cent.; daily average consumption of coals per paddle engines 124 tons; ditto screw engines 178 tons; total daily consumption, 302 tons.

General Remarks.

May 16, at 9.45 A.M., started paddle and screw engines ahead slow; 10.1 A.M., full speed; at 11.45 A.M., stopped engines off Bell Buoy, waiting for steam tender.
May 17, at 12.55 P.M., discharged pilot off Bell Buoy; at 1 P.M., started paddle and screw engines ahead full speed; at 7.45 P.M., weigh shaft of Port Forward, paddle engine broke, stopped paddle engines, and disconnected slide of said engine; at 11.45 P.M., started paddle engines ahead full speed; paddle engines stopped four hours; working with three engines.
May 18, light W. breeze and heavy swell.
May 19, light N.N.E. breeze and heavy sea running.
May 20, light S.E. by S. breeze, fore and aft sails set.
May 21, fresh S.S.E. breeze, fore and aft and square sails set.
May 22, fresh N.N.W. breeze, and heavy sea running. At 6.30 A.M., the bottom escape valve of paddle port after cylinder got gagged, stopped paddle engines, and cleared it; 7 A.M., started paddle engines ahead full speed.
May 23, fresh N.N.E. breeze, fore and aft sails set, screw engines racing, passed several icebergs.
May 24, strong N. breeze, fore and aft sails set, heavy sea running.
May 25, fresh N.W. breeze and heavy sea running, fore, aft, and square sails set.
May 26, light N.N.W. breeze, sea smooth.
May 27, at 1 A.M., stopped paddle and screw engines to take soundings; at 2.40 A.M., started paddle and screw engines ahead full speed; at 4.42 A.M., stopped paddle and screw engines to take pilot on board off Montauk Point; at 5.55 A.M., started paddle and screw engines ahead full speed; at 6.20 A.M., slowed paddle and screw engines, dense fog; at 6.40 A.M. full speed; at 9.10 A.M., stopped paddle and screw engine to take Custom House officers on board; at 9.20 A.M., full speed.
May 28, at 3.30 P.M., paddle and screw engines working easy; at 4 P.M. paddle and screw engines working slow; at 4.30 P.M., stopped paddle and screw engines, and dropped anchor in Flushing Bay.

ABSTRACT OF ENGINEER'S LOG OF THE "GREAT EASTERN." SEVENTH VOYAGE FROM NEW YORK TO LIVERPOOL, JUNE, 1863.

Date each day, ending at Noon.	Paddle Engines. Revolutions of Engines each day.	Paddle Engines. Average Revolutions per minute.	Paddle Engines. Average Pressure of Stm. in Engine-room.	Paddle Engines. Tons of Coal used each day.	Screw Engines. Revolutions of Engines each day.	Screw Engines. Average Revolutions per minute.	Screw Engines. Average Pressure of St'm. in Engine-room.	Screw Engines. Tons of Coal used each day.	Total quantity of Coal used each day.	Number of Knots run by Paddle Engines.	Number of Knots run by Screw Engines.	Distance run by Ship in Knots.	Latitude.	Longitude.	Course.	Barometer.	Observations on Rolling of Ship. Inclination to windwd.	Inclination to leeward	No. of oscil. per min.
			lbs.	Tons			lbs.	Tons	Tons	K.	K.	K.				inches.	deg.	deg.	
June 7 ...	7,262	...	...	87	25,700	...	17½	141	228	...	...	120	St	eering by	the land.	...	...	...	...
June 8 ...	12,142	9·0	21	115	47,530	34·7	17½	172	287	307	346	250	40·15 N.	65·24 W.	N. 81·23 E.	29·50	...	...	...
June 9 ...	11,721	8·3	21	116	48,990	34·7	17½	173	289	288	354	270	41·25 N.	59·28 W.	N. ·75 E.	29·90	...	...	...
June 10 ...	12,176	8·6	21	119	49,430	35·0	17½	179	298	305	361	284	43·20 N.	53·38 W.	N. ·66 E.	29·70	...	...	...
June 11 ...	12,026	8·62	21	123	47,370	34·0	17½	177	300	300	342	268	44·43 N.	47·38 W.	N. ·72 E.	29·07	...	...	...
June 12 ...	12,928	9·2	21	120	49,560	35·2	17½	178	298	320	360	289	46·52 N.	41·21 W.	N. 63·19 E.	29·06	...	...	...
June 13 ...	13,167	9·3	21	117	50,310	36·0	17½	173	290	323	367	297	48·21 N.	34·26 W.	N. 72·46 E.	29·05	...	...	...
June 14 ...	12,488	8·55	21	108	40,050	35·0	17½	148	256	332	274	267	49·30 N.	27·53 W.	N. 75·2 E.	29·07	...	...	...
June 15 ...	13,600	9·7	21	123	49,140	35·0	17½	178	301	341	359	294	50·7 N.	20·24 W.	N. 82·46 E.	29·05	...	...	...
June 16 ...	14,650	10·4	21	123	49,300	35·0	17½	173	296	367	359	312	50·39 N.	12·24 W.	N. 83·56 E.	29.06	...	...	...
June 17 ...	14,499	10·42	21	121	46,990	35·0	17½	173	294	359	353	325	Steeri	ng by the	land, various.	29·03	...	...	...
June 18 ...	5,052	10·6	21	33	16,800	35·0	17½	58	91	124	120	90	...	...	...	...	...	...	...
Total	141,711	9·54	21	1305	521,170	35·3	17½	1923	3228	3366	3595	3066	...	...	...	...	...	...	...

Actnal time of steaming from Montauk Point to Bell Buoy, 10 days 6 hours 6 minutes. From New York to Montauk Point, 12 hours 15 minutes. Density of water in boilers, 1⅝; vacuum in paddle engines, 25; vacuum in screw engines, 25; extreme diameter of paddle wheel, 50ft.; effective diameter 48ft. = 150·79ft. each revolution; pitch of screw, 44ft.; average distance run per hour, 12·47 knots; immersion on leaving New York, 27ft. forward,—aft. 28ft. 5in.; ditto on arrival at Liverpool, 23ft. 6in. forward,—25ft. 10in. aft.; slip of paddle wheels, 9·8 per cent.; slip of screw, 17·25 per cent.; average daily consumption of coals by paddle engines, 122 tons; ditto by screw engines, 178 tons; total daily consumption of coals, 300 tons.

General Remarks.

June 7, at 12.15 p.m., started paddle and screw engines ahead slow, engines working very easy; at 11p.m., stopped paddle and screw engines and dropped anchor; dense fog; at 5.30 a.m., started paddle and screw engines ahead slow; at 6.40 a.m., stopped paddle and screw engines to discharge pilot off Montauk Point; at 7.10 a.m., full speed, the paddle and screw engines working very easy, 12 hours and 15 minutes. Paddle and screw engines working full speed 5 hours, from time of pilot leaving till noon.
June 8, Light E.N.E. breeze, sea smooth, square sails set, dense fog, engineers standing by paddle and screw engines; paddle and screw engines stopped 20 minutes to take soundings.
June 9, Fresh W., S.S.E., S.E. variable breeze and heavy sea running.
June 10, Light S.E. to S.W., breeze and heavy swell, dense fog; engineers standing by paddle and screw engines.
June 11, Light S.W. breeze and heavy swell, dense fog; engineers standing by paddle and screw engines; stopped 20 minutes to take soundings.
Jnne 12, Fresh W. breeze, square sails set, and heavy sea running, dense fog; engineers standing by paddle and screw engines.
June 13, Fresh W.N.W. breeze, and heavy sea running, square sails set, screw engines racing.
June 14, Fresh N.W. to S.W. breeze and heavy sea running, square sails set, screw engines racing; at 5.33 a.m., the adjusting slab of crosshead of Port Forward screw engine broke, stopped engines, and fitted a wood substitute; at 10 a.m., started screw engines; screw engines stopped, 4½ hours; speed of ship by paddle engines alone, 7 knots per hour.
June 15, Light breeze, sea smooth, fore and aft sails set.
June 16, Light breeze, sea smooth, fore and aft sails set.
June 17, at 4 p.m., stopped paddle and screw engines to put a corpse overboard; at 4.40 p.m., full speed; paddle and screw engnies stopped 40 minutes; light breeze, sea smooth.
June 18, at 4.43 p.m., stopped paddle and screw engines to take pilot on board; at 4.55 p.m., started engines ahead full speed; at 8 p.m., stopped engines off Bell Buoy to wait for tide; all particulars of engines taken up to this time.

ROYAL INSTITUTION OF GREAT BRITAIN.

ON SCIENTIFIC EXPERIMENTS IN BALLOONS,

By JAMES GLAISHER, Esq., F.R.S.

In the introductory part of the discourse, Mr. Glaisher gave a brief history of aërostation, from the discovery of the fire-balloon in the year 1782, by the two brothers Montgolfier, noticing some of the principal ascents made with fire-balloons. He then spoke of the discovery of Cavendish in 1776, *viz.*, that hydrogen gas was fully ten times lighter than common air; when it immediately occurred to Dr. Black, of Edinburgh, that if so, a thin bladder filled with this gas ought to rise of itself: yet a period of several years elapsed before this obvious property was applied to the inflation of balloons; not in fact till the success of the fire-balloon was established. He then spoke of the more remarkable ascents and experiments which were made with air-balloons within a few years of its discovery, and remarked, that the result of the several experiments having proved that the balloon would raise great weights in the air, and remain for a long time thus suspended, caused a general desire to navigate the lofty regions of the atmosphere, and to pursue meteorological and other investigations in those regions, and the invention of the balloon was looked upon as likely to be followed by great consequences. He then spoke of the different ascents which have been made in the interests of science: the first of which was that of Mr. Boulton, well known as the partner of the famous Watt, who constructed a balloon to which a match and serpent were attached, that the gas might explode in the air. The object was to determine whether the reverberating sound of thunder was caused by echo or by successive explosions; the point remained unsettled, owing to the shouting of the people; but it was thought that the sound did resemble thunder.

This experiment was made on December 26, 1784. No further experiments were made, so far as he knew, till the beginning of the present century, when in the years 1803 and 1804, Mr. Robertson made three ascents from St. Petersburg, for the purpose of making magnetical and other experiments.

On August 23, 1804, MM. Gay-Lussac and Biot ascended from Paris for a similar purpose; they attained an altitude of 13,000ft., and found no difference in their experiments in electricity, magnetism, and galvanism from those made on the earth.

On September 15, Gay-Lussac ascended alone to a height of 22,977ft.; he found that the temperature declined from 82° to 15°; that the sky was deep blue; that the time of horizontal vibration of a magnet was shorter with elevation.

In 1806, Carlo Brioschi, Astronomer-Royal at Naples, endeavoured to ascend higher than Gay-Lussac; the balloon burst, but its remnant happily checked the rapidity of the descent.

A period of forty-four years followed, during which no systematic attempts were made to take scientific observations by means of balloons.

In 1850, MM. Bixio and Barral inflated a balloon with hydrogen gas, in the gardens of the Observatory at Paris, with the intention of ascending to a height of from 30,000 to 40,000ft.; in their first ascent they ascended to a height of 19,000ft., and descended to the earth in 47 minutes; they passed through a mass of cloud 9000ft. in thickness.

In their second ascent, clouds were reached at 7000 or 8000ft., which proved to be 15,000ft. in thickness; they never, in fact, passed out of the clouds; for when they were 23,000ft. high, they began to descend, owing to a rent in the balloon.

Mr. Welsh's experiments were made in the year 1852: on August 17 and 26, October 21, and November 10, the respective heights attained in these were 19,500ft., 19,100ft., 12,640ft., and 22,930ft.: a great number of observations were made, from which the following law regarding the decline of temperature with elevation was deduced :—

"That the temperature of the air decreases uniformly with the height above the earth's surface, until at a certain elevation, varying on different days, the decrease is arrested, and for a space of 2000 or 3000ft. the temperature remains nearly constant, or even increases by a small amount: the regular diminution being afterwards resumed and generally maintained at a rate slightly less rapid than in the lower part of the atmosphere, and commencing from a higher temperature than would have existed but for the interruption noticed."

These results, as well as those found by Gay-Lussac relative to the decline of temperature with increase of elevation, appeared to confirm the law which theory, based upon observations upon mountain sides, assigns for the gradation of temperature; *viz.*, a decrease of one degree of temperature for every increase of 300ft. Up to the present time therefore the high expectations entertained on the discovery of the balloon have never been realized.

The speaker then proceeded to state, that since the formation of the British Association, grants of money have been made for the purpose of pursuing these inquiries; but with the exception of those by Mr. Welsh, none have been made.

In the year 1861, another grant of money was made, and a committee appointed to carry out experiments by means of the balloon, and the task of making these experiments was undertaken by the speaker.

The primary object of the experiments with which he was entrusted were :—

The determination of the temperature of the air and its hygrometrical states at different elevations up to five miles.

To compare the readings of an aneroid barometer with those of a mercurial barometer up to five miles.

To determine the electrical state of the air.

To determine the oxygenic state of the air by means of ozone papers.

To determine the time of vibration of a magnet on the earth, and at different distances from it.

To determine the temperature of the dew point by Daniell's Dew Point Hygrometer, Regnault's Condensing Hygrometer, and by the use of the Dry and Wet Bulb Thermometers as ordinarily used, and by their use when under the influence of the aspirator, so that considerable volumes of air are made to pass over their bulbs, at different elevations, as high as possible, but particularly up to those heights where man may be resident or where troops may be located, as in the high lands and plains of India, with the view of ascertaining what confidence may be placed in the use of the Dry and Wet Bulb Thermometers, by comparison with the results as found from them and with those found directly by Daniell's and Regnault's Hygrometers; and to compare the results as found from the two hygrometers together.

To collect air at different elevations.

To note the heights and kind of clouds, their density and thickness at different elevations.

To determine the rate and directions of different currents in the atmosphere.

To make observations on sound.

To note atmospherical phenomena in general, and to make general observations.

The speaker then described the method of managing a balloon, spoke briefly of the several ascents already made, and then proceeded to speak of some of the results.

Speaking of the ascent on July 17, the departure of the temperature from a regular progression was very remarkable. Below the cloud the decrease was nearly uniform; on passing above it there was an increase of 6°; the decrease was then resumed, and the temperature was 26° at 10,000 feet, and continued at this reading till 13,000 feet had been passed; a very remarkable increase then took place, and at 19,500 feet a temperature of 42° was registered, and then declined rapidly to 16° at five miles. In descending, a disturbance from a regular increase was met with at 24,000 ft., and continued to 17,000ft.; at 13,000ft. clouds were reached and no observations were made below 10,000ft.

The temperature of the dew point approached that of the air in the cloud but did not touch it, and then separated more and more until at the highest point there was almost an entire absence of moisture.

On August 18, the temperature of the air decreased as usual on leaving the ground, until at the height of 4000ft. the rapidity of the decrease was checked and a warm current of air was met with and continued to 11,000ft.; the balloon then descended and passed through the same warm current extending to the same limits, and again passed through it on its re-ascension at about the same height, and extending to 14,000ft., when the regular diminution was resumed and continued to the highest point; on descending, the same warm current was met with, and continued till the clouds were entered at 6500ft., which caused another interruption in the regular increase of temperature, as is usual on entering cloud.

In the ascent on September 5, on passing out of the cloud there was an increase of temperature of 9°; and then no interruption was met with till a height of 15,500ft. was reached, when a warm current of air was reached, and continued to 24,000ft; then a regular decrease was experienced till the highest point was reached.

On descending, the same warm current was encountered between 22,000 and 23,000ft.; and a similar interruption, but to a greater amount, was experienced till the balloon had descended to about the same height as it was first met with on ascending. After this there was no further interruption till the descent was completed.

A table was then formed from all the other observations, showing the decrease of temperature for successive increases of elevation of 1000ft. The results are as follows :—

When the Sky was Cloudy.

	Ft.		Ft.		Deg.				Deg.		Ft.
From	0	to	1000	was	4·7	from	7	experiments, or	1	in	213
„	1000	to	2000	was	4·2	from	7	„	1	in	239
„	2000	to	3000	was	4·1	from	10	„	1	in	244
„	3000	to	4000	was	3·7	from	10	„	1	in	271
„	4000	to	5000	was	3·1	from	6	„	1	in	323

But When the Sky is partially Clear.

	Ft.		Ft.		Deg.				Deg.		Ft.
From	0	to	1000	was	7·2	from	5	experiments, or	1	in	139
„	1000	to	2000	was	5·3	from	5	„	1	in	189
„	2000	to	3000	was	4·6	from	5	„	1	in	254
„	3000	to	4006	was	3·4	from	6	„	1	in	295
„	4000	to	5000	was	2·7	from	7	„	1	in	370

These results differ considerably from those formed in a cloudy sky, and doubtless the difference between experiments carried on under a cloudless sky would differ still more. They do not at all confirm the theory of a decline of 1° of temperature in 300 feet.

The Decrease of the Temperature of the Air, at heights exceeding 500 *feet.*

	Ft.		Ft.		Deg.						Ft.
From	5,000	to	6,000	was	2·8	from	10	experiments, or	1	in	357
„	6,000	to	7,000	was	2·8	from	8	„	1	in	357
„	7,000	to	8,000	was	2·7	from	8	„	1	in	370
„	8,000	to	9,000	was	2·6	from	8	„	1	in	384
„	9,000	to	10,000	was	2·6	from	8	„	1	in	384
„	10,000	to	11,000	was	2·6	from	8	„	1	in	384
„	11,000	to	12,000	was	2·6	from	6	„	1	in	384
„	12,000	to	13,000	was	2·5	from	6	„	1	in	400
„	13,000	to	14,000	was	2·2	from	6	„	1	in	455
„	14,000	to	15,000	was	2·1	from	9	„	1	in	477
„	15,000	to	16,000	was	2·1	from	9	„	1	in	477
„	16,000	to	17,000	was	1·9	from	9	„	1	in	527
„	17,000	to	18,000	was	1·8	from	9	„	1	in	556
„	18,000	to	19,000	was	1·8	from	9	„	1	in	556
„	19,000	to	20,000	was	1·5	from	9	„	1	in	667
„	20,000	to	21,000	was	1·3	from	9	„	1	in	771
„	21,000	to	22,000	was	1·3	from	9	„	1	in	771
„	22,000	to	23,000	was	1·0	from	9	„	1	in	1000
„	23,000	to	24,000	was	1·3	from	2	„	1	in	771
„	24,000	to	25,000	was	1·1	from	2	„	1	in	909
„	25,000	to	26,000	was	1·0	from	1	„	1	in	1000
„	26,000	to	27,000	was	1·0	from	1	„	1	in	1000
„	27,000	to	28,000	was	0·9	from	1	„	1	in	1012
„	28,000	to	29,000	was	0·8	from	1	„	1	in	1050

These results follow almost in sequence with those found with a partially clear sky; and together show that a change takes place of 1° of temperature in 139 feet near the earth, and only in 1000 feet at the height of 30,000 feet, and plainly indicates that the decline of 1° of temperature must be abandoned.

Treating the observations for determining the degrees of humidity of the air in the same way, the following are the results:—

When the Sky was cloudy, saturation being considered as 100,

On the earth the degree of humidity was	78	from	5	experiments.
At the height of 1000 the degree of humidity was	76	„	9	„
„ 2000 „	77	„	11	„
„ 3000 „	75	„	11	„
„ 4000 „	80	„	10	„
„ 5000 „	81	„	5	„
„ 6000 „	82	„	3	„

The law of moisture here shown is an almost uniform state of humidity to the height of 3000 feet, viz., 76·5; then a decrease on the next 1000 feet, and an increase to 83 and 82 at 5000 and 6000 feet.

When the Sky was partially clouded.

On the ground the degree of humidity was	63	from	4	experiments.
At the height of 1000 the degree of humidity was	68	„	5	„
„ 2000 „	77	„	5	„
„ 3000 „	76	„	5	„
„ 4000 „	76	„	7	„
„ 5000 „	69	„	6	„
„ 6000 „	68	„	6	„

At heights exceeding 6000 feet, the following were the results:—

	Ft.					
At the height of	7,000	the degree of humidity was	64	from	7	experiments.
„	8,000	„	58	„	7	„
„	9,000	„	52	„	7	„
„	10,000	„	82	„	7	„
„	11,000	„	48	„	5	„
„	12,000	„	48	„	8	„
„	13,000	„	43	„	5	„
„	14,000	„	58	„	2	„
„	15,000	„	53	„	3	„
„	16,000	„	45	„	3	„
„	17,000	„	33	„	3	„
„	18,000	„	21	„	2	„
„	19,000	„	36	„	2	„
„	20,000	„	33	„	1	„
„	21,000	„	12	„	1	„
„	22,000	„	31	„	1	„
„	23,000	„	16	„	1	„

The laws of moisture here indicate a humidity near the ground less by 15 with a partially clear sky, than in a cloudy sky; starting with 63 in the former state on the ground, increasing to 77 at 300 feet high; then nearly constant to 5000 feet, when it abruptly decreased to 69 and 68 at 5000 and 6000 feet, and then decreased nearly evenly at the rate of 5 in 1000 feet, till at 9000 and 10,000 feet it was 52; the degree then constantly decreased till at a height exceeding 25,000 feet it was less than 10, and it would seem that at higher elevations there was an almost entire absence of water. These seem to be the general laws; but this regular diminution is evidently very often interrupted, and strata of moist air may exist, or be passing at different elevations, even up to 20,000 feet, of some thickness.

Electrical State of the Air.—In the ascent on July 17, the air was found to be charged with positive electricity, becoming less in amount with increased elevation, till at the height of 23,000 feet, the amount was too small for observation. The instrument was broke in the descent, and was not afterwards used.

Time of a Vibration of a Magnet.—The general result of all the experiments is, that the magnet vibrates in a somewhat longer interval of time at higher elevations than on the earth. This result is contrary to that found by Guy-Lussac in 1804.

On the Propagation of Sound.—From observation made in the different ascents, it was learnt that different notes and sounds pass more readily through the air than others; for instance, the barking of a dog and the whistle of a railway engine have been heard at a height of more than two miles, whilst the shouting of several thousand people cannot be heard at the height of one mile.

On the Oxygenic Condition of the Atmosphere.—On July 17, the test papers by Moffat and Schönbein were untinged by colour throughout the journey; and the same result was found during the ascent on July 30.

On August 10, Mr. Glaisher received a letter from Dr. Moffat, of Hawarden, expressing his surprise at this result, inasmuch as it has always been received as a theory, that ozone increases in quantity with increased elevation.

In consequence of this, Mr. Glaisher went to Dr. Moffat, at Hawarden, and requested him to make some papers, which he did, and these papers were used on August 18, together with some prepared by Messrs. Negretti and Zambra, and some prepared according to Schönbein's formula; and at 22,000ft. the coloration was 4 on a scale whose deepest tinge is 10, whilst those prepared by Schönbein were coloured to on the same scale, and those by Negretti and Zambra were uncoloured; in consequence of this, the preparation of the papers by Messrs. Negretti and Zambra has been stopped.

Physiological Observations.—On July 17, before starting, the number of Mr. Coxwell's pulsations were taken, and found to be 74 in one minute; and Mr. Glaisher's 76 in one minute.

At a height of 17,000ft., Mr. Glaisher's had increased to 100, and Mr. Coxwell's to 84; and on reaching the ground, the number was 79 with both gentlemen.

On August 21, no observations were taken before starting. At the height of 1000ft., the following results were obtained:—

Mr. Coxwell	96	per minute.
Mr. Ingelow	80	„
Capt. Percival	90	„

At 11,000 feet—

Mr. Coxwell	90	in a minute.
Mr. Ingelow	100	„
Capt. Percival................................	88	„
Mr. Glaisher	88	„
Master Glaisher	89	„

At 14,000 feet—

Mr. Coxwell	94	per minute.
Mr. Glaisher	98	„
Mr. Ingelow	112	„
Capt. Percival	78	„
Master Glaisher	89	„

The pulsations of Capt. Percival were so weak that he could scarcely count them; whilst those of Mr. Coxwell he considers had increased in strength.

From these results it will be seen that diminished pressure exercises a different influence upon different individuals.

On July 17, at 19,000 feet the hands and lips were noted as being dark-blue, not the face. At the height of four miles the palpitations of the heart were audible, and the breathing was affected.

On August 18, the hands and face were blue at the height of 23,000 feet.

On September 5, at the height of about 29,000 ft, Mr. Glaisher became unconscious, and at 35,000 feet Mr. Coxwell lost the use of his hands. At 29,000 feet on descending, Mr. Glaisher began to recover, and at 25,000 feet the observations were resumed.

The general results of these eight ascents are :—

1st. That the temperature of the air does not decrease uniformly with the height above the earth's surface, and consequently the theory of a decrease of 1° of temperature for an increase of elevation of 300ft. must be abandoned. In fact, more than 1° declined in the first hundred feet when the sky was clear, and not so much as 1° in 1000ft. a height exceeding five miles.

These experiments are the first to yield any definite information on the subject; more experiments are required to settle the law satisfactorily, but its effect on the laws of refraction will be great: all the elevations of the balloon are to a certain extent erroneous, for it has never happened that the mean of the extremities has given the mean of the whole column of air.

2nd. The degree of humidity decreased wonderfully with the height till at about five miles there was scarcely any aqueous vapour at all.

3rd. That an aneroid barometer can be made to read correctly, to the first place of decimals certainly, and to the second place of decimals probably, to a pressure as low as 7in.

4th. That a dry and wet bulb thermometer can be used effectively up to any height on the earth's surface where man may be located.

5th. That the balloon does afford a means of solving with advantage many delicate questions in physics.

ON SOME CHEMICAL AND PHYSICAL PROPERTIES OF SOILS, AND THE PRODUCTIVE POWERS OF THE SOILS OF ENGLAND.

In all fertile soils we find variable quantities of organic matter—ready-formed ammonia, nitric acid, potash, soda, lime, magnesia, oxides of iron, chlorine, phosphoric, sulphuric, and silicic acids; in short, all the mineral matters which are found in the ashes of plants. These minerals, or ash constituents, it need scarcely be observed, are not merely accidental but essential materials, without a proper supply of which no plant can grow luxuriantly and come to full maturity. In one sense all are equally important; for the absence or deficiency in the soil of one, be it lime or potash, phosphoric or silicic acid, is detrimental to the luxuriant development of the vegetable organism. No one who has given the slightest consideration to this subject will hesitate to give assent to this mineral theory.

It is natural to connect the productiveness of soils with the proportion of ash-constituents of plants which they contain; but although in some cases a soil may be unproductive on account of the absence or deficiency of lime or potash or phosphoric or any other mineral matter which enters into the composition of plants, in the majority of cases the chemical analysis of different soils affords little or no indication of their relative productive powers.

The combinations in which the mineral constituents of plants exist in the soil, their unequal or uniform distribution in the surface, the composition and physical condition of subsoil, the relative depth of both, the porosity of the land, and especially the power of absorbing and retaining as well as modifying in a variety of ways the crude manuring agents which are applied to the land, unquestionably are intimately connected with the great variations which we notice in the agricultural capabilities of different soils.

Before the publication of Liebig's celebrated "Chemistry in its Application to Agriculture," a work which has given the death-blow to the humus theory, the fertility or barrenness of a soil was generally considered to depend entirely upon its physical properties and the presence or deficiency of humus. Soon after the publication of Liebig's writings, scientific men fell into the opposite extreme, and expected, the bare chemical analysis of a soil and the ash-analyses of plants would enable them to discover at once the means of restoring the fertility of land, or to improve it by certain purely mineral manuring mixtures, and to grow on it, irrespective of its natural adaptation to the growth of particular crops, any kind and almost every amount of agricultural produce.

These unphilosophical views have rendered agricultural chemistry less popular than formerly, but also more scientific and more directly useful to the enlightened agriculturist.

A new direction to chemico-agricultural enquiries was given about ten years ago by Professor Way's highly important researches on the absorptive powers of soils for manure. Professor Way's investigations originated in an observation of Mr. Thompson, of Kirby Hall, York, who found that soils have the faculty of separating ammonia from its solution.

On passing solutions of ammonia through different soils, Way found that all possess the power of retaining ammonia, some more, some less. He also observed that potash, lime, magnesia, and phosphoric acid are absorbed by all soils to a considerable extent.

Still more important are his experiments, which prove that cultivated soils not only absorb free alkalies and acids, but have likewise the power of separating ammonia, potash, and other bases from their saline combinations.

Professor Way principally operated with simple salts: it may therefore be urged, that it by no means follows, as a necessary consequence, that because a soil absorbs ammonia when a solution of sulphate of ammonia is passed through it, the same absorption will take place when an ammoniacal salt mixed with some dozen other substances is filtered through it.

I therefore operated with complex liquids, and already, in 1857, published several filtration experiments in the Journal of the Royal Agricultural Society.

These and many subsequent experiments have shown that all soils not only possess the power of absorbing and retaining potash, ammonia, phosphoric and silicic acid, and other mineral matters, but also of modifying in the most varied way the composition of complex saline solutions which are passed through them.

The following table shows the results obtained in filtering the same kind of liquid manure through two very different soils, taken from the neighbourhood of Cirencester.

An imperial gallon contains :—	No. 1. Calcareous clay soil.			No. 2. Ferruginous sterile sandy soil.	
	Before contact with soil.	After contact with soil.	Loss or gain.	After contact with soil.	Loss or gain.
Water and volatile ammonia compounds	69,888·14	69,886·60	—1·54	69,894·25	+ 6·11
Containing :—					
Ammonia, as carbonate & humate of ammonia	(35·58)	(20·81)	—14·77	—(33·15)	— 2·43
Organic matters	20·59	34·77	+14·18	—(25·06)	+ 4·47
Containing nitrogen......	(1·49)	(1·84)	+ ·35	— (1·70)	— ·09
Equal to ammonia	(1·81)	(2·23)	+ ·42	— (1·70)	— ·11
Inorganic matters.........	(91·27)	(78·63)	—12·64	—(80·69)	—10·58
Consisting of :—					
Soluble silica	2·34	·70	— 1·64	— 5·10	+ 2·76
Oxide of iron...............	none	2·55	+ 2·55	— 2·07	+ 2·07
Lime	11·48	22·42	+10·94	— 8·03	— 3·45
Magnesia	2·87	1·17	— 1·70	— ·74	— 2·13
Potash........................	16·92	3·40	—13·52	—12·01	— 4·91
Chloride of potassium ...	2·74	none	— 2·74	none	— 2·74
Chloride of sodium	40·35	33·31	— 7·04	—39·25	— 1·10
Phosphoric acid............	4·83	·60	— 4·93	— 1·92	— 2·91
Sulphuric acid	3·94	2·88	— 1·06	— 3·67	— ·27
Carbonic acid, and loss...	5·80	11·60	+ 5·80	— 7·90	+ 2·10
	70,000·00	70,000·00		70,000·00	

The preceding analytical results, amongst other particulars, show :—

1. That the calcareous clay soil absorbed about six times as much ammonia from the liquid manure, as the sterile sandy soil.
2. That the liquid manure in contact with the calcareous clay soil, becomes much richer in lime; whilst during its passage through the sandy soil, it becomes purer in lime.
3. That the calcareous soil absorbed much more potash than the sand soil.
4. That chloride of sodium, in conformity with the results of other observers, was not absorbed to any extent by either soil.
5. That both soils removed from the liquid most of the phosphoric acid.
6. That the liquid in passing through the calcareous soil becomes poorer: and, on the other hand, in passing through the sandy soil becomes richer in soluble silica.

The property of soils to store up food for plants is thus not confined to one particular kind of fertilizing matter, but it applies to them all, and manifests itself in a way which is modified by the composition of the soil.

In these, and in all other experiments which I have since made, the ammonia, potash, phosphoric acid, and other fertilizing matters contained in a solution were never completely absorbed by any soil, however weak or concentrated the solutions were that were filtered through the soil. Indeed, if the solution of saline matters which are brought into contact with soil are very dilute, scarcely any absorption of ammonia, potash, or phosphoric acid takes place.

Sewage of towns, on account of the very diluted condition in which this liquid is usually found, in percolatiug through a soil scarcely leaves any of its soluble constituents in the soil in a fixed or less soluble form, although the soil possesses in a high degree the power of absorbing and retaining soluble fertilizing matters.

All soluble saline matters, however useful or necessary they may be, impede the rapid growth of plants, if they are presented too abundantly or in too concentrated a solution to the roots of plants. One of the functious of the soil appears to be to transform such readily soluble compounds into combinations so little soluble in water, that they pass in commou life as insoluble, but which are still sufficiently soluble to supply the growing plaut with the necessary amount of mineral food in a state of solution.

This beautiful power of soils thus not only effectually prevents the waste in fertilizing matters which heavy rains would otherwise occasion, but also rectifies in a great measnre any misapplication which may be made of concentrated soluble fertilizers.

The power of soils to modify manuring matters depends in a great measure on the chemical composition of the soil, and also on the concentration of the liquid and the quantity of soluble fertilizing matters which is incorporated with that portion of the soil which is penetrated by the roots of plants. Hence the effect which one aud the same manure is capable of producing varies greatly in different soils, aud also with a rainy or dry season.

The office of the soil is not merely to supply mineral food to plants, but also to manufacture, so to say, crude food into a condition fit for assimilation; to prevent injury to the living plant by too large an accumulation of soluble matters in the surface soil; to store up for future use such an excess; to diffuse it equally in that portion of the land reached by the roots of plants; and to modify it in conformity with the requirements of our crops, in a manner differing with each description of land.

Respectiug the causes of the absorbing properties of soils, the opinions of chemists are divided.

Liebig regards this power as analogous to, if not identical with the physical power which charcoal possesses in retaining colouring matters, aud consequently cousiders the soluble fertilizing matters which are brought into contact aud absorbed either wholly or partially by the surface soil, as present in what he calls a physical state of combination.

Professor Way, on the other hand, believes the absorption to be due to the presence of certain double silicates of alumina in the soil. Thus, for instance, the double silicate of alumina and soda when brought into contact with lime, according to Way, parts with its soda and takes up lime. When the double silicate of alumina and lime thus formed is brought into contact with magnesia, lime passes into solution, and a double silicate of alumiua and maguesia is formed; this in its turn is decomposed by a salt of potash; and the double silicate of alumina and potash by the salt of ammouia; thus finally, a double silicate of alumina and ammonia is produced.

Such displacements indeed took place on repeating Way's experiments: but wheu a preparation made after Professor Way's directions, and containing silica, alumina, and ammouia, is mixed with an excess of a solution containing a salt of potash, ammonia passes into the solution and potash is absorbed by the preparation. From a similar preparation containiug silica, alumiua, aud potash, an excess of a solution of a lime salt removes potash, and lime becomes absorbed.

But as in no case I have been able to uotice a substitution of one base for another in equivalent proportious, and no double silicate of a definite composition cau be produced by Mr. Way's plan of operation, and the existence of such definite compouuds in soils has never been demonstrated, I would suggest a different cause or causes which are in operation when potash, ammonia, and other fertilizing matters are fixed in the soil.

The absorption of soluble fertilizing matters by soils I believe may readily be explained by a reference to well-known chemical facts. The absorption of soluble phosphates or phosphoric acid is readily explained by the affinity which carbouate of lime, oxide of iron, and alumina, which occur in every fertile soil, possess for phosphoric acid.

In the absorption of potash and ammonia, I am of opiuion that the hydrated oxides of iron and alumina in the soil have a great share. Like all bases of the formula R_2O_3, these oxides in a hydrated condition, in relation to strong alkalies, are weak acids, in consequence of which they have a teudency to unite with potash or ammonia under favourable circumstances.

The absorption of ammonia, potash, and of phosphoric acid by soils accords with well-known chemical facts; and as these substances are by far the most important fertilizing agents, it may be maintained that the principal absorptive properties of soils are due to chemical and not to purely physical causes.

The mechanical or physical condition of soils, however, affects very materially their productive powers; and it is only in a soil in a proper physical condition that the chemical properties can properly manifest themselves.

Great stress is laid by Liebig, as it is indeed by all good farmers, on the mechanical cultivation of the land. Liebig directs special attention to the physical state of combination, as he calls it, in which the mineral matters must exist in the surface soil, in order that they may be of utility to the plant. Whatever may be the precise meaning of the term "physical state of combination," or whether we assume that mineral food must be preseuted to plants in solution, or in some other mysterious form variously represented iu Liebig's "Laws of Husbandry," certainly mineral food cannot be of any service to plants except it be present in the surface soil in an available form. The word "available," perhaps conveys as correct a meaning as the more novel and less graphic expression, 'physical state of combination."

In such an available condition mineral food cannot be brought into the surface soil, unless water can freely percolate through the land. This is effected by various mechanical means, such as subsoiling, trench-ploughing, surface stirring, &c. By all these means the porosity, aud with it its capillary attraction, is improved. As soon as continued dry and warmer weather sets in and vegetation makes a fresh start, the mineral food prepared previously in the lower strata of the soil begins to move in an upward directiou. With the evaporation of moisture from the surface, fresh food is couveyed into the surface soil by capillary attraction, and thus the fertility of the latter is again restored. The appearance of nitre, and similar saline efflorescences on the surface of soils during long-continued dry weather, sufficiently shows the display of capillary attraction.

This explains why the exhausted surface of land, abounding at a greater depth iu mineral riches, remaius unproductive when it rests on an impervious undrained subsoil; why winter-fallow does not materially restore the fertility of the surface if it is not accompanied by repeated ploughings, subsoiling, and similar mechanical operations, tending to increase its porosity; and why in a well-cultivated clay-soil vegetation is most luxuriant when the intervals between wet and dry weather are neither too short nor too prolonged.

Looking at the different soils of England, we meet with two extremes,—naturally barren sands and rich fertile clays. Between these two extremes we find all gradations; some partaking more of the characters of the one class, and others more of the properties of rich clay land.

Many originally barren soils, by dint of abundant manuring, the cultivation of green crops, which are consumed on the land by fattening sheep, by the purchase of oil-cakes and other kinds of conceutrated food, and the increased production of home-made manure, have been brought into a high state of cultivation. But although in this improved conditiou they yield large crops of wheat, barley, and roots, it can hardly be said that their permanent fertility has been materially increased. Left to themselves, they soon again become unproductive, and therefore require constantly a renewal of those constituents which are removed in the crops grown on such land. High farming, in reference to light sandy soils, restores to the land infinitely more mineral matter of the most valuable kind than is removed in the corn-crops sold off the farm. As regards such land, high farmiug cannot therefore be called a system of robbery.

Deep, rich clay-soils, on the other hand, often contain, practically speakiug, an inexhaustible supply of potash, phosphoric acid, magnesia, soluble silica, &c. The amount of miueral matter takeu from such land by a long succession of the most exhausting crops is quite iusignificant in comparison to that existing in twelve or eighteen inches of soil.

The actual state of fertility of land, however, does not so much depend upon the absolute amouut of mineral plant-food in a given depth of soil, as upon the proportion which exists in the surface in an available condition, or as Liebig calls it a "physical state ef combination."

Mechanical cultivatiou, the judicious use of ammoniacal manures, the restoration of particular miueral matters which, like phosphoric acid, are most speedily removed from the surface and alternate cropping, are some of the meaus of repairing the fertility of the surface.

On light sandy soils, deficient in potash, phosphoric acid, and other mineral matters, ammoniacal salts or nitrate of soda should be avoided; but on soils abounding in mineral food, such dressings may be used with great advantage.

Ammoniacal salts certainly increase the solubility of mineral matters and promote their diffusion in the soil. Still, making all allowance for this they appear to have a special effect on some crops and not on others. Thus cereals are improved by them, but not clover or beaus. In a series of most valuable experiments by Messrs. Lawes and Gilbert, the plots continually manured with mineral matters produced only a slightly increased crop of wheat, nor was the produce increased to any extent in those years in which mineral manures were put on the land every alternate year; whereas in the years in which ammouiacal salts were applied alternately one year and mineral matters the following, a very great increase in the wheat crop was obtaiued, which was likewise the case when ammoniacal salts were continuously used year after year.

With regard to the relative importance of the various fertilizing matters, it may be stated that ammonia or nitrates unquestionably are most useful substances, which the intelligent farmer may turn into profitable account, and the unreasoning one often abuses in a high degree.

But as the atmospheric as well as the rain invariably contain both ammouia and uitric acid, and as all cultivated soils contain both ready-formed ammonia and nitrogenised organic matters, which on gradual decomposition furnish ammouia or nitric acid or both, the application to the soil of nitrates or ammoniacal salts is not of the same esseutial primary importance as that of those mineral matters in which the land is deficient. Magnesia, lime, silica, sulphuric acid, chloride of sodium, and even potash, are either present in most soils in great abundance, or if deficient in particular soils, may be economically incorporated with them iu the shape of marl, burnt clay, or gypsum, by the consumption of purchased food on the land. All these mineral matters have much less value than phosphoric acid, which is but sparingly distributed in most soils, and is largely required by all plants. Accordingly the removal of phosphoric acid from the laud leads more rapidly to partial exhaustion, especially of naturally poor soils, than the removal of any other ash-constituent. Fortunately modern science and commercial enterprise have brought to light the fact, that large deposits of phosphatic materials occur far more abundautly in various parts of the world, than was supposed not many years ago.

[Of the phosphatic materials actually used in England for the mauufacture of artificial manures, the following were exhibited:—South American bone-ash; Cambridgeshire and Suffolk coprolites; apatite from Norway; phosphorite from Estremadura; Sombrero, or rock guano, and phosphatic crusts, from Monk's Island, Jarvis Island, Baker Island, aud various other small islets in the Carribbæn Sea.]

Should the supply of Peruvian guano come to an end, which it will before mauy years, English agriculturists will still continue to reap the benefits which commercial enterprise, manufacturiug skill and capital, more extended agricultural knowledge, steam-power applied to the cultivation of the land, intelligent labour and applied science have already conferred upon this highly-favoured country.

Conclusive proofs can be given, showing that so far from being in a progressive

state of exhaustion, the productiveness of the soils of England has wonderfully increased during the last fifty years; and that the deporable but hitherto unavoidable loss which the sanitary laws of a civilised country necessitate, is perfectly insignificant in comparison with the immense amount of mineral riches in the great majority of soils, and with the abundant restoration of fertilizing matters to naturally poor land.

INSTITUTION OF CIVIL ENGINEERS.

THE CHARING CROSS BRIDGE.

By Mr. Harrison Hayter, M. Inst. C.E.

It was stated that this bridge consisted of nine spans,—six of 154ft. and three of 100ft.,—the centre opening of the Hungerford Suspension Bridge having been divided into four spans each of 154ft., that on the Surrey side into two spans also of spans also of 154ft. each, and the opening on the Middlesex side into three spans each of 100 feet—the superstructure over the latter being fan-shaped. The width of the river, at the site of the bridge, was 1350feet. The greatest depth of water between the two brick piers of the original bridge was 13ft. below low-water spring tides, and the average depth was about 9ft.; the rise of spring tides being $17\frac{1}{2}$ft. The level of the rails was 31ft. above Trinity high-water mark, and there was a clear minimum headway under the bridge of 25ft. above the same datum.

The superstructure was carried by cylinders sunk into the bed of the river and by the piers and abutments of the suspension bridge, the abutments having been considerably lengthened. The cylinders, excepting at the fan end were, 14ft. diameter below the surface of the ground, and 10ft. diameter above, the junction between the two sizes being effected by a conical length. There were four piers formed of these cylinders, each consisting of two cylinders, 49ft. 4in. apart from centre to centre. They were of cast iron, $1\frac{1}{8}$in. in thickness throughout, and the circumference was divided into segments, with interior flanges round all the edges, through which the segments were bolted together; and a horizontal interior rib was also cast in the middle of each segment. There were thus continuous vertical lines of ribs, securing a strong columnar arrangement.

The strata through which the cylinders were sunk consisted of mud and gravel, of varying thicknesses, overlying the London clay. The sinking was effected by excavating the material from the inside—at first by divers, but after the London clay was reached and the water was pumped out, in the ordinary way—and by weighting the cylinders, to an average load of 150 tons each. These cylinders were sunk to depths of 52ft., 62ft., and in one case to 72ft. below Trinity high-water mark. They were filled with Portland cement concrete up to where the conical length commenced, and above with brickwork, set in Portland cement mortar, to the underside of the granite bearing blocks, which were 2ft. 6in. in thickness, and projected 1in. above the top of the cylinders, in order that the weight might not come on the upper edge of the ironwork. With a view of testing the strength of the foundations, the two cylinders in the pier nearest to the Surrey side, after being completed up to the level of high-water and filled with concrete and brickwork, were each weighted with 700 tons, being about equal to the greatest load they could possibly have to sustain, supposing the four lines of rails on the bridge to be loaded with locomotive engines. This caused the cylinders to sink permanently 4in. To bring the other cylinders to a bearing, so as to prevent any settlement after the completion of the bridge, from the weight of the permanent and moving loads, they were each weighted with 450 tons, when it was found that they permanently sank, on an average, 3in. each. Each pair of cylinders forming a pier was connected together transversely by a wrought-iron box girder, 4ft. deep, which also served as a cross-girder for supporting the roadway. Assuming the four lines of way on the bridge to be loaded with locomotive engines, the pressure on the base of the cylinders would amount to 8 tons per square foot, and on the brickwork at the top of the cone to about 9 tons per square foot.

The superstructure of each of the 154ft. openings consisted of two main girders, to the underside of which were suspended cross-girders, for carrying the roadway platform. These cross-girders extended beyond the main girders, and formed a series of cantilevers on the outer sides, for supporting two footpaths, each 7ft. wide in the clear. The main girders were of wrought-iron, and were not continuous, but extended only over one opening. Each girder had to support, inclusive of its own weight, a maximum distributed load of 750 tons. The extreme depth of these girders was 14ft., and the depth between the centres of gravity of the top and bottom members was 12ft. 9in. The sides of the girders between the bearings were divided into fourteen equal parts by a pair of vertical bars, connected to the top and bottom by pins of puddled steel, 7in. diameter at the ends of the girder, decreasing to 5in. diameter at the centre; and each division contained a double set of two diagonals crossing each other. The top and the bottom of these girders were of boiler-plate, and consisted of horizontal tables 4ft. and 3ft. wide respectively, and of four vertical ribs, the two outer rows being 24in. deep, and the two inner rows 21in. deep. The aggregate thickness of the plates in the horizontal table of the top in the centre of the girder was $3\frac{1}{8}$in. and in the bottom $3\frac{13}{16}$ without the angle irons, and of $4\frac{1}{8}$in. and $4\frac{13}{16}$in. respectively with the angle-irons, but exclusive of the angle-iron covers. It was arranged that, with the greatest load, the maximum strains should not exceed 4 tons per square inch in compression, and 5 tons per square inch in extension. All the rivet-holes were drilled by machines capable of drilling several holes at one time. This plan was, under the circumstances, less costly than punching, besides which a great saving was effected in putting the work together. The diagonals acting as ties were of Howard's rolled suspension links, each separate tie being composed of two or three links, as required, rivetted together. The diagonals acting as struts were each in one solid forging, and were united together in pairs by zigzag bracing of wrought iron. In the centre of the girder, where the diagonals acted as both struts and ties, the pairs were united together in the two central spaces by the zigzag work. The dimensions of the struts varied from 12in. by 3in. at the ends to 6in., by $2\frac{1}{2}$in. in the middle, and of the ties from 12in. by $2\frac{1}{2}$in. at the ends to 6in., by 2in. in the middle. The ends of the girders over the piers were boxed in, with plates $\frac{3}{8}$in. thick, stiffened by angle and T irons. Over the cylinders the girders rested on sheet lead, laid upon the granite blocks. On the brick piers and the Surrey abutment, they rested upon roller bed-plates. The girders were put together in place on a staging, the upper and lower platforms of which were accurately adjusted to the proper camber. The whole of the plates were drilled, and the struts and ties were completed, before being sent to the works. The weight of each main girder was 190 tons. One of the main girders was tested when in its place with a distributed load of 400 tons, when the greatest deflection observed was $1\frac{5}{16}$in., and the permanent deflection after the load was removed was $\frac{1}{2}$in.

The cross girders of the 154ft. openings were of wrought iron, and were generally similar in character to the main girders, from which they were suspended, at intervals of 11ft. apart, from centre to centre. They were 4ft. deep in the middle, and 2ft. $1\frac{1}{8}$in. deep where the cantilevers were united to them outside the main girders. The top and bottom consisted of two plates, 18in. wide by $\frac{3}{8}$in. thick, the sides being of lattice bars united to the top and bottom by angle irons. The cantilevers decreased from 2ft. $1\frac{1}{8}$in. deep at their junction with the cross girders to 1ft. 2in. deep at their extremities. Each cross-girder, including the two cantilevers, weighed 9 tons. When two of these cross girders, without the cantilevers, were tested with a load of 140 tons, equivalent to 70 tons on each girder, the maximum deflection in the centre was 1in., and the permanent deflection when the load was removed was $\frac{1}{8}$in.

The superstructure of the three 100ft. openings of the fan end was supported by the brick pier and abutment on the Middlesex side of the suspension bridge, and intermediate to these by two rows of seven and of nine cast iron cylinders respectively. These cylinders were 10ft. diameter below the ground level, the outer ones being 8ft. diameter, and the inner ones 6ft. diameter above that level. They were sunk to depths averaging 40ft below Trinity high-water mark, and were filled with Portland cement concrete to about 5ft. above that level; but it was not considered necessary to fill in the remaining portion of these cylinders. On account of the great width of the fan end, which increased from 49ft. 4in. at the brick pier to 168ft. at the abutment, the plan of supporting the roadway on cross girders, suspended from outside main girders, was inadmissible; and as it was not desirable to introduce intermediate main girders, projecting above the line of rails, the roadway was carried by interior plate girders, laid at right angles by the piers and abutments, and by the outside main girders, which were laid at the angle of inclination of the fan. The outside main girders were of the same depth, and were generally of the same character, although lighter in all parts, and were fixed at the same level, as the girders of the 154ft. openings. The interior plate girders were of the ordinary construction, 5ft. deep, or one-twentieth of the span, and weighed 26 tons each. The triangular spaces between the outside main girders and the outer interior plate girders were filled in with cross-girders, terminated by cantilevers, projecting beyond the face girders, and similar to those outside the main girders of the 154ft. openings.

The roadway platform over the 154ft. openings consisted of planking 4in. thick, spiked to longitudinal timbers, 15in. by 15in., placed underneath the rails, and bolted to the cross girders. Over the fan end, the platform consisted of planking 6in. thick, secured to the girders. The footpath platforms were of planking 6in. thick.

The first cylinder of the Charing Cross bridge was pitched on the 6th of June, 1860, and as the bridge was now on the eve of completion, its construction would thus extend over a period of about three years. The weight of wrought iron in the bridge, including the steel pins, was 4950 tons, and of cast iron, 1950 tons. The total cost, including the abutments, would be £180,000, or £1 15s. per square foot, and £131 per lineal foot. The cylinders of the 154ft. openings cost complete £20 per lineal foot; the outer cylinders of the piers of the fan end cost about £12, and the inner ones about £10 per lineal foot. The bridge was designed by Mr. Hawkshaw (President Inst. C.E.), the engineer to the Charing Cross Railway Company; and was carried out under his immediate supervision. Mr. John H. Stanton (M. Inst. C.E.) being the resident engineer. Mr. George Wythes was the contractor for the construction of the railway, but this bridge was sublet to Messrs. Cochrane & Co., whose representative on the works was Mr. Joseph Phillips (Assoc. Inst. C.E.)

DESCRIPTION OF THE LYDGATE AND OF THE BUCKHORN WESTON RAILWAY TUNNELS,

By Mr. J. G. Fraser, M. Inst. C.E.

It was assumed that the aggregate length of the tunnels now daily traversed by railway trains in the United Kingdom amounted to 80 miles; and supposing their cost to have been on an average £45 per lineal yard, their construction must have caused the expenditure of six and a half millions sterling. Up to the present time this interesting branch of Civil Engineering had not been much discussed at the Institution: as the Minutes of Proceedings only contained accounts of a total length of about 3 miles, involving an outlay of about one quarter of a million sterling. Each tunnel had its own history, and its construction demanded peculiar treatment, according to the character of the strata, the springs of water, etc. If particulars of these works were transmitted to the Institution from time to time more effectual measures might in many cases be practised, with advantage to public economy.

The tunnels forming the subject of this communication were both executed under the immediate superintendence of the Author, as Resident Engineer for Messrs. Locke and Errington, the Engineers-in-chief.

The Lydgate Tunnel, on the Oldham branch of the London and North Western Railway, was driven through the coal measures. A longitudinal section which accompanied the Paper, prepared from actual measurements taken during the progress of the works, illustrated the geological details. Faults were common in this formation: sometimes severing it in the line of the dip, and at others in the line of the bearing. Several distortions were encountered, and at one point, one-half of the tunnel was in strong shale and rock, and the other half in wet and loose shale. The total length of the tunnel was 1332 lineal yards; of this about 1046 yards were on a straight line, and 286 yards on a curve of 74 chains radius; its width was 25ft. at the level of the rails, with a height of 20ft. Four permanent shafts, each 9ft, in diameter in the clear, were sunk at intervals of about 230yds., of the respective depths of $53\frac{1}{3}$, 80, $75\frac{2}{3}$, and 53 yards. They were lined with 9in. brickwork, or with 12 inches of masonry, except in the rock. An old colliery shaft, which had been closed for many years, was also re-opened, and a cross-heading was driven from it into the tunnel, a distance of $13\frac{1}{3}$ yards. When foul air was met with, a supply of fresh air was forced into the workings by means of fans, until a junction was effected between the headings. There was a considerable amount of choke-damp in the neighbourhood of the old coal workings. To overcome its effects, a bore-hole was sunk from the surface, which was lined with an iron pipe, and through this fresh air was forced into the tunnel. The sinking of the shafts was carried on in the usual manner. by excavating through soft material, and by blasting and drilling through rock. The average rate of progress was 11 lineal yards per month. After attaining a depth of 20 yards, the material was raised by engine power.

A bottom heading was driven from the faces worked from the cuttings at each end; but with these exceptions the tunnel was mined by a top heading, $6\frac{1}{2}$ft. by $4\frac{1}{2}$ft. first being made for the full distance of each length. The crown was protected by larch bars and poling boards, and after the ground was secured, it was gradually widened out to the shape of the tunnel, the same description of timbering being continued to about 10ft. above the formation level. The contract price for the excavation, including the timbering, was 4*s*. 6*d*. per cubic yard. In the construction of a tunnel, the masons, or bricklayers, should, as a rule, commence the lining as soon as possible after the ground was prepared for them by the miners. The lengths mined at each face varied according to the nature of the ground; averaging in loose shale, 3 lineal yards, through stony shale 5 yards, and through rock 8 yards, or in some instances 10 yards. The prices paid to the miners ranged from £8 to £18 per lineal yard, one half of the total length amounting to £12, or less.

The centres used were skeleton ribs, set about $1\frac{1}{4}$ yard apart; but at the leading ends two ribs were fixed close together. This description of centering was found to answer very well. The price allowed for setting each rib was 8*s*. The masonry of the side walls was of coursed rubble. The arch for a length of 632 lineal yards was turned with fitted rubble, but owing to the scarcity of good bedded stone, the remaining length was built of brickwork. The average quantity of masonry per lineal yard was $12\frac{1}{2}$ cubic yards, and the contract price throughout was 20*s*. per cubic yard. The mortar was composed of Barrow stone lime mixed with coal-ashes, in the proportion of 2 to 1, ground by heavy iron rollers, and used fresh. Its setting properties were most satisfactory. The spaces between the crown bars, called the mid-feather, were filled up with brickwork, and the bars themselves were left in where they had "sagged."

The first length of the tunnel was keyed in on the 27th of October, 1854, and the last was finished on the 21st of March, 1856, a period of seventeen months, or equivalent to about 80 lineal yards completed per month, exclusive of the sinking of the shafts. The contract price for the tunnel was £26 per lineal yard through rock, and £35 16*s*. per lineal yard through shale, the average price being £30 per lineal yard.

The Buckhorn Weston Tunnel, on the Salisbury and Yeovil Railway, was 397 lineal yards in length, 25ft. in extreme width, and 20 feet in height above the level of the rails. It was constructed through Kimmeridge clay, intersected with veins of loose rock. These veins acted as conduits for a large body of water, amounting to about 90 gallons per minute, which flowed in at the crown of the tunnel for nearly one-half its length. To remedy the evil effects arising from this volume of water, a heading, 5ft. by 5ft., was driven above the tunnel, and about 10 yards on the upper side of it, for a length of 200 yards. A pipe 12 inches diameter, was laid in this heading, and the remainder of the space was filled in with loose stone. The water was thus intercepted, and conveyed away from the work. It was originally intended to execute this tunnel by means of a bottom heading, sufficiently large for ordinary waggons, from the cutting at the west end, and to sink two shafts. After the heading had been driven for a length of 200 lineal yards, it was found that the action of the atmosphere caused the sides to bulge in so much that this plan had to be abandoned. A smaller heading was then substituted, and three additional shafts had in consequence to be sunk. The shafts, which were only temporary, were 8ft. square, and were lined with timber. Their cost amounted to £1 10*s*. per lineal yard of tunnel.

The mining was performed in a similar way to that of the Lydgate Tunnel; a top heading being first driven for each shaft. The average price for mining and tipping was 4*s*. 6*d*. per cubic yard, and the quantity amounted to 80 cubic yards per lineal yard of tunnel. The lengths mined at each face ranged from $3\frac{1}{2}$ lineal yards in heavy ground, to 5 lineal yards in favourable strata. The average cost of mining was £30 per lineal yard, exclusive of the shafts. The crown bars were of larch, 18in. diameter, and were fixed about 18in. apart.

The centres were strongly braced, and were placed about $1\frac{1}{4}$ yard apart. Each rib contained 35 cubic feet of timber, and 285 lbs. of wrought iron in bolts and straps, and the cost of setting amounted to 6*s*. per lineal yard of the tunnel. As side pressure was anticipated at the commencement of the work, the first ten lengths were built with an invert, which contained 4 cubic yards of brickwork, per lineal yard. Further experience showed, however, that this was not necessary. The tunnel was built throughout of brickwork, upwards of six millions of bricks being used, and the average quantity per lineal yard of tunnel was 20 cubic yards. For a length of 390 lineal yards, where the water occurred, the work was 2ft. 8in. in thickness. The spaces behind the brickwork were filled in solid, and throughout the heavy ground three bars were left in, on an average in each length. As there was no sharp sand in the neighbourhood, burnt clay, fine sand, and broken bricks were ground together, and mixed with Bridgewater hydraulic lime, in the proportions of 2 to 1; the result was perfectly satisfactory.

The first length of this tunnel was keyed in on the 6th of October, 1858, and the last was completed on the 17th of February, 1860, a period of sixteen months. The total cost had amounted to £53,000, or £72 per lineal yard; detailed particulars being given of the cost of the different items.

PUBLIC WORKS IN PERNAMBUCO, IN THE EMPIRE OF BRAZIL.

By Mr. W. M. Peniston, M. Inst. C.E.

It was stated that the object of this paper was to describe a few of the public works of one of the most extensive, productive, and least-known empires of the world. Pernambuco was one of the principal, but by no means the largest, of the twenty provinces of which the empire consisted. It had an area about equal to England, whilst its population was estimated not to exceed one million. The commercial capital was built on a low, sandy flat, but little raised above the level of the ocean, and surrounded by an amphitheatre of hills. Its position was selected on account of the natural harbour formed there by a reef, or in Portuguese, Recife, the true name of the city. This reef ran for hundreds of leagues parallel to, and only a short distance from, the coast. In the neighbourhood of Recife, it was composed of soft, calcareous, and silicious sandstone, intermixed with shells of existing species. In consequence of the absence of quays with sufficient depth of water for vessels to come alongside, all cargoes had to be shipped and discharged by means of lighters.

After alluding to the amount of shipping frequenting the port, the character and extent of the exports and imports, the currency, and the weights and measures, reference was made to the climate of Pernambuco; and it was stated that in the city, which was less healthy than the country, with a population of 120,000, until lately without any drainage, and with a consumption of about $\frac{3}{4}$ of a gallon of water per head per diem, the death rate was only $1\frac{3}{4}$ per cent., per annum. The variations in the temperature were considerably less, and the regularity of any hour was much greater, than in this country. Thus, in the summer the temperature did not vary more than 1° above or below 82° at 9 a.m. in the shade, nor in the winter 2° above or below 78° at the same time. The rainfall in 1860 was 67·20in., in 1861 it amounted to 123·75in., and for the first six months in 1862 it was 53·64in. The extreme recorded rainfall during this period occurred in January, 1861, when it amounted to $7\frac{1}{4}$in. in twenty-four hours, of which upwards of 4in. fell in six hours. The highest floods in the valleys crossed by the Recife and Sao Francisco railway varied from 15 to 25ft.; but these rose very rapidly, as frequently the river was in its usual quiescent state in the evening, and in the morning it was a raging torrent.

The waterworks and the gas works in the capital were then briefly noticed, after which the streets and street transport came under review, including the Government roads and bridges. The principal streets of the city, which were extremely narrow, were pitched, or very roughly paved, with broken granite, brought from Europe as ships' ballast. Outside the town, the total length of road passable during the greater part of the year for wheeled carriages throughout the province was about 130 miles. Of this one-sixth only was metalled. In some districts the roads were practically useless, from the want of bridges across the rivers; in others timber bridges had been built, but on the new roads now being made under the direction of Mr. W. Martineau (M. Inst. C.E.), the Government engineer, iron bridges had been adopted. The cost of the roads had been in times past, almost fabulous, exceeding that of European railways. But according to the latest contracts, the cost was under £3000 a mile, including the bridges, but exclusive of the metalling, the price of which a short time back amounted to upwards of £1 per cubic yard, when broken and spread in place. The bullock tracks were scarcely available for public traffic, which was at present chiefly carried on by pack-horses, on tracks barely wide enough for two horses to pass each other, and pursuing a most devious course.

There was properly no river navigation in Pernambuco; but the Sao Francisco, which rose in the hills in the rich mining district at the back of Rio Janeiro, flowed northward from Minas Geras, till it entered the province at its southwest angle. It there precipitated itself over the Falls of Paulo Affonco, a depth of nearly 200ft., whence it took its course through a rocky rapid channel for nearly 200 miles to the sea. Above these falls the river was navigable to the Falls of Pira Pora, a distance of from 600 to 800 miles, and it was to this as a feeder that the railways from Recife and Bahia were both directed.

The absence of river navigation, the inefficiency and great cost of public roads, and the horrible character of the common roads of the country, naturally led to the consideration of a railway. This was brought forward by Messrs. de Mornay, who proposed to carry a line throughout the entire length of the province from Recife, the capital, to the Falls of Paulo Affouco, on the Rio Sao Francisco. A concession was granted with a guarantee of 5 per cent. from the Imperial Government, and of 2 per cent. from the Provincial Government, upon the estimated cost of completing the first portion of the line from Recife to the River Una, a distance of about 75 miles. The original estimate was for a line on the North American system at £540,100, but considerable alterations and improvements had caused the capital to be increased to £1,200,000, to which amount the guarantee

was extended; but as this last has not been sufficient to complete the line, the Government had now agreed to a further extension of the capital, to cover the sum actually expended on the works.

The country traversed by the first portion of the Recife and Sao Francisco Railway to the River Una, presented a great uniformity of its physical features. It consisted of a succession of narrow valleys, with hills from 100 to 150ft. in height, composed almost without exception of a rock of a granitic character, varying from a state of perfect decomposition to its natural hardness, the proportion of soft ground to hard rock being at least 10 to 1. It was decided that the curves should not be sharper than 20 chains radius, or the gradients steeper than 1 in 80, nor longer at that inclination than 2 miles. In no case had the specified gradient approached the limited length, and in two cases only had it exceeded 1 mile in length. There was only one tunnel, and that under 500ft. in length. The earthwork on the heaviest part of the line averaged for about 20 miles, 40,000 cubic yards, per mile—which was double that on the other sections—the highest embankment and the deepest cutting being 40ft. The width of the cuttings at the formation level was 20ft., reduced to 10ft. in rock. The width of the embankments at the same level was 16ft., their height being fixed at 18in. above the highest known floods. There were eight principal bridges, all of iron, varying in height from 15 to 25ft., and numbering together two spans of 90ft., two of 80ft., eighteen of 60ft., and one of 50ft. The permanent way consisted of the ordinary double-headed rail, laid on creosoted larch cross sleepers; but 10 miles of the line had been laid, as an experiment, with Greave's "pot" sleepers. Trials were being made of native timber for sleepers as well as for keys, and samples of upwards of one hundred kinds of timber were exhibited, most of which were easily obtainable within a short distance of the railway, and would be available for temporary purposes, but probably not more than a dozen or twenty would be useful for any permanent work.

The stations and station arrangements, the rolling stock, the engine and carriage sheds, and the workshops for repairs and for waggon building, were then severally described. It was stated that the works of the railway were commenced in May, 1858, and the whole of the first section to the River Una was finally opened in November, 1862. Part of the line had now been in operation for five years, and during that time there had not been an accident to a passenger, even when five engines had been at work at the same time on a length of 20 miles of single line. This was very creditable to the locomotive superintendent and engine drivers, as the responsibility rested with them, the other officials, with the exception of the traffic manager, being all natives.

The labour question was one of the most vital importance to the future of Brazil. Agricultural operations had heretofore been conducted exclusively by slaves, as also, mainly, the work of porters and lightermen about the ships, harbour, and warehouses of Recife, for some years past, however, the laws against the further importation of slaves had been strictly enforced, so that their number had gradually decreased. Liberal concessions had been granted from time to time by the Government for the promotion of colonisation, but with no commensurate success. Experience had proved that, both in the province of Pernambuco and in the adjoining province, there was an ample supply of manual labour for any public works, or extension of agricultural operations, at present probable. But the difficulty was to persuade the native Brazilians that it was to their advantage to seek employment. The only work that the native was accustomed to was ditching, and the only tool, the hoe. The first lesson was to induce a native to give up the hoe, and take to the pick and shovel. Want of order and discipline prevented them from working a barrow road properly, and from tipping a waggon; but a light hand-cart they worked very well, and they would fill a set of ballast waggons in less time than might be expected, at a cost of 9*d.* to 10½*d.* per cubic yard, exclusive of road-laying and repairs. Men's wages varied from 3*s.* to 3*s.* 9*d.* per day, the latter pay being for picked men in all cases.

Although the difficulties were great in getting the native labourer into order, temper and perseverance would overcome them with time: but with the native artizans the difficulties were greater still, as there were so few mechanics in the principal towns, scarcely sufficient for the ordinary work, that they were even more independent than the common labourer, and infinitely more conceited and wedded to their own ways. The native country carpenter had but one tool, the "euxo," or hand adze, and not having the slightest idea of square or line, all his work had to be set out. His wages were from 4*s.* 6*d.* to 5*s.* 9*d.* per day. Brickwork and masonry cost, for labour only, from 9*s.* to 14*s.* per cubic yard, according to the thickness and the height; the wages varying from 4*s.* 1*d.* to 6*s.* 6*d.* per day. Native smiths received 5*s.* 6*d.* to 6*s.* 9*d.*, and painters 6*s.* 9*d.* to 9*s.* per day. From the description which was given of the capabilities of the native workmen, it was believed that foreigners must be imported for all the higher orders of work.

Pernambuco produced, in common with most provinces of Brazil, very superior timber, and of infinite variety; but the difficulty of getting it, and the absence of roads and the means of transport, rendered foreign timber cheaper at the seaports, and at all places at any distance from the forests. This was also the case with regard to stone, the ashlar dressings used in the public buildings and in the best finished private houses having been sent from Lisbon. The native bricks were of the rudest description, and were used in all stages, from that of being simply sun-dried to sound kiln-burnt. In consequence of the action of the atmosphere on the native bricks, it was necessary to plaster all exposed work. The Brazilian or Portuguese tile was almost invariably used for covering roofs, and although attempts had been made to introduce corrugated iron and other materials for roofing, nothing could compare, where ventilation was so important, with the ordinary tile of the country.

The Appendix contained a list of the standard dimensions of the Recife and San Francisco Railway, and of the principal structures upon it, as well as of the rolling stock. Also, tables of the wages of the different classes of labourers and artizans, of the prices of the materials, and the cost of various kinds of work and of transport.

ON THE MANUFACTURE OF DUPLICATE MACHINES AND ENGINES.

By Mr. John Fernie, Assoc. Inst. C.E.

After referring to the block-making machinery, designed by the elder Brunel for Portsmouth Dockyard, and to the Small Arms' Factory at Enfield, as examples tending to show that the system of duplicates both cheapened and improved the manufacture of all articles to which it could be applied, the Author remarked that, until lately, little or nothing had been done in its application to the manufacturing of machines or engines on a large scale. It was true the principle had been acknowledged, and various writers had urged the desirableness of its introduction into the railway system; but with such large component parts, special machines were out of the question, and the only other possible mode was working to a correct standard.

Mr. Whitworth (M. Inst. C.E.) had advocated, in several papers read before different scientific societies, the adoption of a system of measurement for mechanical engineering work, in which the inch was to be the basis, subdivided into a thousand parts for the finer dimensions. In 1851, he exhibited a machine for obtaining fine accurate measurements by touch, and he showed, by models, that the thousandth of an inch was not only an appreciable quantity, but in many cases its difference was what constituted a bad fit.

The Author having long been satisfied that the mode of taking dimensions in the workshop was behind the times, had, with the sanction of Mr. Kirtley, the locomotive superintendent, established during the last five years, in the workshops of the Midland Railway at Derby, a system which had proved most beneficial, not only in reducing the cost of the work, but in greatly improving it; and at the same time perfecting the only plan by which all the parts of engines could become duplicates of one another. The system of end measurement and a gravity piece, as invented by Mr. Whitworth, was adopted, and a machine was constructed capable of taking in 100 inches. This machine consisted of a strong bed plate, having on the upper surface a V groove, planed throughout its whole length. At one end there was a headstock, through which a square spindle, fitting the groove, was propelled by a hand wheel, which formed the nut of a screw having ten threads to an inch. This nut was in two parts, and could be tightened up by screws, so as to prevent lateral play; and a collar and washer, also adjustable, prevented any play in the headstock. The other end of the bed had also a headstock and screw movement, so as to adjust the length of the pieces in the groove, and bring the readings of the index to O. The difference between this machine and Mr. Whitworth's was in the way the subdivisions of the inch were obtained. In the Whitworth machine a screw with exactly ten threads to an inch was first made; whereas in this machine, as a screw could not be found with exactly ten threads, it was necessary to run a thread on the face of the hand wheel, and sub-divide this for the length required for an inch. The manner of obtaining duplicates with this machine was exceedingly simple. First a perfect inch was got, and then a second was made, by means of the gravity piece; after which, all other sizes up to 100-in. were readily obtained. These sizes were now kept as duplicates. The finer dimensions were read from the divisions on the wheel, and from these, gauges for use in the workshop were made. All dimensions were thus duplicate multiples, or divisions of an inch, and a bare one-sixteenth of an inch became not an unknown quantity, variable with the rule or the eye of the workman, but so many thousandths of an inch, which were stamped on the gauges, and were soon understood. One of the first applications of the system in the workshop was to establish the necessary degree of tension required to ensure a perfect fit of a wheel on its axle. The result of experiments showed that with a difference of ·005 of an inch in the dimensions, there was a small permanent set in the wheel boss, but with a difference of ·003 of an inch the set was hardly perceptible. It was found however that, with ordinary lathe work, ·003 was rather to fine a dimension, as lathes were seldom exactly true in their spindles. The size ·005 was then finally adopted. In shrinking on outside cranks it was found that ·015 was sufficient to retain them in their places, while cross-head spindles 2½in. diameter required a difference of ·004, and levers with 3in. holes of only ·001.

The gauges were then described, as well as the manner in which the lengths of the eccentric rods were preserved uniform, and how the key groove in the outside cranks and the eccentric key grooves were cut. No setting out was required, and there was no chance of mistake from the carelessness of workmen. Unless the cranks and eccentrics were exact, they would not fit the tools, and thus a certainty was attained in the depth and position of the key groove.

Considerable improvements had been effected of late years in plate moulding, and the plan adopted at the Midland Railway Works at Derby, was believed to be the first application of the system to such large and complicated castings as locomotive cylinders. Moulding boxes for axle brasses were exhibited, and a description was given of the manner of moulding cylinders. By this mode, a minimum quantity of sand was used, the projecting pieces cast on the boxes, did away with the necessity of lifters, the castings came cleaner from the sand, the patterns were not knocked to pieces by rapping, and the cylinders were perfectly true in the bore and passages.

The plan of fitting together the various pieces, so as to ensure uniformity in erection as well as in detail was then described; and it was urged, that by this system of accurate measurement, however large the parts might be, they became duplicates of one another, and could at any time be replaced. The advantages claimed were, economy in manufacture, greater excellence in workmanship, and a perfect system of duplicates, whereby the parts became interchangeable. The author especially recommended this system to the engineers of Indian and Colonial Railways, as there was no reason why the different parts of engines and of rolling stock generally, should not be as perfect duplicates as those of the Enfield rifle.

DESCRIPTION OF THE LINE AND WORKS OF THE SCINDE RAILWAY.

By Mr. John Brunton, M. Inst. C.E.

The importance of the valley of the Indus, as the route for commercial as well as for military communication with the Punjaub and the north-west provinces of India, was pointed out by Sir Charles Napier, the Conqueror of Scinde, so far back as the year 1842; and its many natural advantages subsequently attracted the notice of other eminent men. When, therefore, railways were introduced into India, attention was soon drawn to the Indus valley route, having Kurrachee as its sea terminus; and a concession having been granted to Mr. W. P. Andrew, the Scinde Railway Company was formed in 1855. This Company embraced under its management not only the Scinde Railway proper, or the line from Kurrachee to Kotree on the Indus, 108 miles, but also the Punjaub line from Moultan to Lahore and Umritsir, 240 miles, and likewise a flotilla of steamboats for navigating the river from Kotree to Moultan, 570 miles. Within the last three months the Government had entrusted to the same Company the construction of a line from Umritsir to Delhi, 280 miles, where a junction would be effected with the northern terminus of the East Indian Railway. The total length of these four sections was 1198 miles, but the accounts of each section were kept perfectly distinct.

The construction of the first section of this line, from Kurrachee to Kotree, which had been graphically described as "the neck of the funnel" of the entire system, formed the subject of this communication. After alluding to the works in progress for increasing the depth of water over the bar at the mouth of the harbour of Kurrachee: which was not only the natural port of Scinde, but also of the Punjaub and of Central Asia, and for extending the quay and wharf accommodation, reference was made to statistical returns, showing the rapid increase which had taken place in the import and export trade of the port during the last quarter of a century. Hitherto all commercial communication with the upper districts had been carried on by native boats on the Indus, or by caffilahs of camels—no roads worthy of the name existing. This led to great expense, inconvenience, and irregularity. The works of the Scinde Railway were commenced on the 29th of April, 1858, their execution having been originally let to Messrs. James and Edwin Bray, contractors; but since June, 1859, the works had been executed departmentally, without the intervention of a large contractor, by the Company's engineers and inspectors, who had thus favourable opportunities for becoming acquainted with the capabilities of the various classes of natives, as well as for ascertaining the cost of each description of work. This mode of carrying on the works was forced upon the Company by the peculiar exigencies of the case; but the author thought, that for the construction of large works in India, under Government guarantee, the employment of a substantial contractor was a preferable plan. To secure the economical execution of the works, a fair tariff of wages was published, and daily payments were guaranteed. This had the effect of collecting a considerable number of labourers. The province of Scinde contained but a sparse population, and the Scindee was naturally indolent and devoid of muscular power, though not deficient in talent. The natives of the surrounding state of Cutch were a much superior race, and from thence came a large proportion of the skilled workmen, such as carpenters, masons, smiths, and other handicraftsmen. From the hill tribes of Beloochistan and Affghanistan a hardy race of labourers were obtained. To maintain discipline amongst this body of men, it was found advisable to organise a regular railway police force; and to facilitate the administration of justice, a special magistrate was appointed by the Government. Owing to these precautions very few outrages of a serious character had occurred. As the line of railway lay at a distance from existing towns and villages, it became necessary to make such arrangements for the feeding, shelter, and health of the different employés as policy, no less than humanity, suggested. The natives worked in gangs under a self-elected muccadum, or ganger, who made all agreements for work, received the earnings for his division, and was himself paid a small per centage by the men. When work was executed by day labour, it was found that its economical execution depended entirely upon the energy and honesty of the muccadum, or native overseer. These qualities were so rare, that piece work had to be resorted to, though it was with difficulty this was established as a rule. The average prices paid for earth and rock work per cubic yard were, alluvial earth excavated from side trenches and placed in embankment, 4.09 pence, firmly set gravel, or soft shaly material 4·9 pence, rock requiring bars, but not blasting, 1*s.* 9*d.*, and hard rock requiring blasting, the powder, drills, &c., being found by the Company, 2*s.* Gravel ballast cost 1*s.*, and broken stone ballast 1*s*, 10*d.* per cubic yard. The average prices of the principal kinds of work, including the cost of the provisional staff of superintendents, but exclusive of that of the permanent engineering staff, were as follows:—

Earthwork in embankments	0*s.*	11½*d.*	per cubic yard
„ in cuttings, a large portion rock of different degrees of hardness	1*s.*	6¾*d.*	„
„ in diversion of roads and streams	0*s.*	8½*d.*	„
Picking slopes	2*s.*	0*d.*	per square yard
Masonry, concrete	4*s.*	6*d.*	per cubic yard
„ dry rubble	3*s.*	0*d.*	„
„ common rubble	12*s.*	0*d.*	„
„ coursed rubble, with rubble backing	15*s.*	0*d.*	„
„ coursed rubble	20*s.*	0*d.*	„
„ block in course	31*s.*	6*d.*	„
„ ashlar	1*s.*	7½*d.*	per cubic foot
Ballast	1*s.*	6*d.*	per cubic yard
Leading and laying permanent way	6*s.*	0*d.*	per lineal yard
Fence walling	3*s.*	0*d.*	„

The province of Scinde being situated in what was termed the rainless zone, the rainfall was very small, the average quantity measured at Kurrachee during the five years ending 31st August, 1860, amounting only to 5·32 inches per annum. Except during the rainy season, the river beds were dry, but in them water could generally be obtained, by sinking to depths varying from 5 to 30 feet. All the water, however, procured from these wells was more or less saline. In the neighbourhood of Kurrachee, the principal features of the country were low hills varying from 150 to 200 feet in height, consisting of a coarse-grained arenaceous rock, of a dirty yellow colour, abounding with fossils. Most of these hills were capped with conglomerate, more or less disintegrated on the surface. The hills lying north of the Indus to the foot of the Hala range, of which they were spurs, exhibited the effect of great disturbance, and the drainage of the country passed through the fissures thus formed. One of the most remarkable of these was at Dharwat, where during the rains the water of the Bahrun rose at times 70 feet, rushing through the pass with overwhelming force. The Kheytriani hills were composed of pale arenaceous limestone, and those in the neighbourhood of the Rhodh river of calcined clays of various colours.

The distance between Kurrachee and Kotree traversed by the Scinde Railway was 108 miles 10 chains. Of this, 32 miles 50 chains were level, and 75 miles 40 chains were on inclines more or less favourable—1 in 200 being the ruling gradient. The total length of straight line was 74 miles 22 chains; the length of the line on curves was therefore 33 inches 68 chains, the sharpest curve having a radius of 43 chains for 76 chains. The earthworks were generally executed to accommodate a single line of railway, but all the bridges, culverts, and stone viaducts were constructed to carry two lines. In the case of wrought-iron viaducts, the stone piers were adapted to support girders for a double line, while those required for a single way only were erected. Between the workshops at Ghizree junction and the terminus at Bunder head, a distance of 3 miles 15 chains, the line was double; and a short branch of 3½ miles in length had been constructed from the workshops to the eastern delta of the Indus. The permanent way consisted of the ordinary double-headed rail, fixed in chairs, laid on transverse wooden sleepers. A large proportion of the sleepers were of yellow pine creosoted, sent from England. It was intended to complete the required quantity with sleepers of deodar timber, from the Himalayas; but the native merchant having been unable to fulfil the contract, a supply was purchased of Australian blue and white gum, and native red eyne sleepers. Their respective costs were creosoted yellow pine 8*s.* 11*d*,, Australian blue gum 8*s.*, and eyne 7*s.* 9*d.* each, delivered at Kurrachee; that of deodar delivered at Kotree being 6*s.* each. The deodar sleepers were at first steeped in a solution of sulphate of copper, to protect them from the attacks of the white ant, but a Burnetizing apparatus had since been erected at Kotree, where the cost of applying the process only amounted to fivepence half-penny per sleeper. The result of the author's experience was, that creosoted yellow pine sleepers split and twist to a great extent, owing to the extreme dryness of the climate, and that they become very brittle. The majority of the fencing consisted of a dry rubble stone wall, having a coping of stones on edge, set in mortar. Locomotive erecting and repairing shops had been built where the Ghizree branch left the line. The organisation of these works, with a view to their ultimate utility, and at the same time having regard to economy, was surrounded with many difficulties. To employ entirely European workmen would have involved enormous cost. It therefore became necessary to call in the aid of native carpenters and smiths, as far as practicable. They first had to be induced to stand to their work, and then to be taught the use of European tools. This had been accomplished by degrees, and the result had been most satisfactory; the carriages now framed and erected at these shops by Cutch carpenters displaying admirable workmanship. To keep up a supply of European foremen, fitters, engine-erecters, and engine-drivers, the system of taking the sons of European soldiers and clerks, as apprentices, had been adopted, by which a staff of men thoroughly acclimatised was being educated in all branches of railway mechanism. The electric telegraph with two lines of wires, carried upon posts of deodar, let into cast-iron sockets, was laid along the

railway. The block system of working the trains was employed; needle-speaking instruments being used for conveying information between the the stations and passing places.

As the line crossed the natural drainage of a great extent of conntry, a large provision for waterway was necessary. It was comparatively easy to fix the spans of the bridges at the rivers and nullahs, but in crossing wide flat plains the question was difficult. The plain at Pipri was nearly five miles broad. Originally a number of culverts was built there, and catchwater drains were cut to conduct the rain into the river Gugger. In 1861 the rain was very heavy in this locality, and the water was ponded up by the embankment, which was soon breached in several places. The line was then lowered to the natural surface of the ground, being in fact laid in a ditch 16 feet wide and 2 feet deep, and during the unusually heavy rains of 1862, the water flowed over the rails to the depth of 9 inches, without either damaging the line or stopping the traffic. Whenever the height of the embankments would admit of it, and to secure the largest amount of waterway, the culverts had a span of 8 feet 6 inches, the permanent way being carried in such cases upon teak beams, which supported a platform of planks, covered with ballast, as a protection from fire. The heaviest piece of masonry npon the line was the large stone viaduct across the Bahrun river. It was 1728ft. in length, and its greatest height was 31ft. 4in. The snperficial measurement of the bridged area was 44,064 square feet. It consisted of thirty-two arches, each 45ft. span, and having a rise of 10ft. 6in. Its total cost was £27,185. This viaduct was completed in twenty-two months and a half. There were six viaducts with iron girders, on Warren's principle, of 80ft. span each, the total number of these spans being forty-two. From experience the author could not speak favourably of these girders, when contrasted with the plate girder, as there was an amonnt of vibration, both laterally and vertically, caused by passing trains, which had the effect of breaking or loosening the bolts fixing the longitudinal timber stringers to the cross girders. The viaduct across the Chinese creek would consist of ten openings, each of 100ft., spanned by girders of plate iron, of elliptic form in elevation.

The extension of railway communications into wild and uncivilised countries demanded from all grades of the employès the exercise of more than ordinary observation, self-discipline and energy. It would therefore be wise policy on the part of all foreign railway companies, and the contractors for the works, to be more strict than they have hitherto been, in ascertaining that the agents sent out from this country at great cost, were something more than proficient in the practical details of their profession, as they ought also to be possessed of gentlemanly feelings and habits, by which alone the respect of the uncivilised native could be obtained, and his services secured, so as to reduce the cost of the work, and convert the railway engineer into a pioneer of civilisation and a missionary of science.

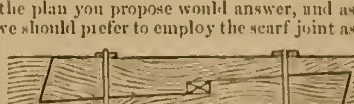
NOTICES TO CORRESPONDENTS.

ERRATUM.—In the last number of THE ARTIZAN, at page 125, under the head of *Locomotive Engineering*, first column, 31st line from the top, instead of reading "*if an arithmetical mean be taken between these and the working load, &c.*," read *if an arithmetical mean be taken between the extreme limits of ultimate strength and the mean working stress, &c.*

A CONSTANT READER AND SUBSCRIBER (EDINBURGH)—cannot do better than consult a very useful little work, written by a Mr. George Ede* which treats specially of the processes upon which our correspondent wishes to be informed. Should you require further particulars write to us. We shall at all times be glad to hear from you.

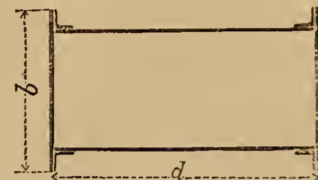
A.—The working pressure of the "Leinster's" Boiler is 20lbs. per square inch. The engines are not fitted with any expansion gear, but the steam is cut off by the slide valves at about ⅝ths of the stroke of the piston. The shafts are of wrought iron. The average vacuum in condensers is about 25in. The total boiler surface exposed to heat is 16,800 square feet. The boilers are not fitted with superheating apparatus.

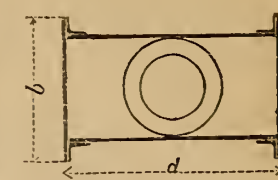
A. E. D. (Roorkee).—We question if the plan you propose would answer, and as it is also unnecessarily complicated, we should prefer to employ the scarf joint as shown in the accompanying sketch, the pieces to be joined, being drawn together by a key or by double wedges, and then bolted through, as shown. As an additional security, straps might be added. BARLOW, in Tredgold's Carpentry, states that —"The length of the scarf should be, if bolts are not used, as follows:—In oak ash, or elm, six times the depth of the beam. In fir, twelve times the depth of the beam. If bolts and indents combined, the length of the scarf should be—In oak, ash, or elm twice the depth of the beam. In fir, four times the depth. In scarfing beams to resist transverse strains, straps driven on tight are better than bolts. The sum of the areas of the bolts should not be less than one-fifth the area of the beam, when a longitudinal strain is to be borne. No joint should be used in which shrinkage or expansion can tend to tear the timbers. No joint can be made so strong as the timber itself."



* The Management of Steel; including Forging, Hardening, Annealing, Shrinking, and expansion; also, the Case Hardening of Iron. By George Ede. Tweedle, 337, Strand London.

ENGINEER (Tubular Cranes).—In answer to your enquiry the proportions for cranes of 15ft. radius, and 20ft. height, should be as follows, viz., depth d = 3ft., breadth, b = 2ft. For compression flange, plates to be ⅜in. thick, for tension





flange, $\frac{5}{16}$in.. angle irons, 2¾in. × ⅜in. thick. The pillar to be 18in. diameter and 3in. metal. The proportions for large cranes of 18ft. radius and 24ft. height should be, depth, d = 3ft. 9in., breadth, b = 2ft. 6in., the plates for compression flange to be ⅜in. thick; for tension flange, $\frac{5}{16}$in. thick. The angle irons to be 3in. × $\frac{7}{16}$in. This crane should, instead of revolving upon a cast iron pillar, be constructed similarly to that illustrated in the ARTIZAN of June, 1862. Should, however, special circumstances render it necessary to employ a pillar, it should not be less than 23in. diameter, and the thickness of metal 3in. The dimensions given are those at the level of the foundation, the depths and breadths to be reduced gradually towards the end of the jib, as shown in the number of the ARTIZAN we have just referred to.

O.—The material to which you refer (Saxifragine) is a recently invented powder for blasting and quarrying purposes which has already gained considerable reputation on the Continent, and has been patented in various countries. The Russian patent has, we understand, been sold to the government of that country, and in Belgium and Prussia, companies have been formed and are rapidly producing the material. The following are some of the objections urged against the use of the ordinary blasting powder:—The ordinary powder is difficult and expensive to transport, on account of the precautions it requires. 2. The expenses for the conveyance, of a small quantity being as great as for a large quantity, consumers must lay in all they require for a considerable time, which is very inconvenient, owing to the great danger involved in storing it. The ordinary Powder being adapted to gunnery and sporting purposes, it has been found that it is often purloined to a largeextent. It also presents great danger to workmen in consequence of its scattering fragments, in all directions with great force. It causes constant interrupting interruption of work, It exercises a pernicious influence on the health of men by the thick smoke and sulphurous gas which remain after explosion. Sulphur is used to some extent in the manufacture of ordinary powder, and its pernicious effects are no where more visible than in mine blasting, added to which must be considered its cost. The inventors claim that all these objections are obviated by the use of saxifragine, which is composed chiefly of nitrate of barytes in place of saltpetre, of which only a very small per centage is introduced; sulphur is entirely dispensed with, and consequently the cost of the material is much reduced, whilst, being from the nature of its composition of a very dilatatory or expansive character, its practical value is considerably enhanced. It is much less dangerons to carry and to store than gunpowder. It is not likely to be purloined, as it cannot be used for firearms. It does not cause the men to be constantly interrupted in their occupation. It does not produce thick smoke or sulphurous gas. It blasts the rock as well or even better than the ordinary powder. Its theoretical force, as compared with that of the ordinary powder, is calculated at 18 to 11 in its favour. Owing to its superior force and density, it occupies less space in the hole, so that the centre of gravity of the charge may be placed low with a shallower hole and equal tamping. It is much less expensive. With reference to its practical application, the method of proceeding with Saxifragine is similar to that adopted with the ordinary powder, but the report of the explosion is far less, whilst the expansive power is greater than that of the powner now in use. The stone is tractured as well as, and even better than it would be by the old process, but the fragments detached are not cast to a distance as is now the case; the pieces are completely detached from the rock, and, the combustion being less instantaneous than that of the ordinary powder, the gas does not produce a violent shock against the sides of the mine, but rather an increasing and progresssive pressure until the rock is ruptured. It may be used in mines and even in some collieries, where, from the danger attending the use of ordinary powder, blasting has, at a great sacrifice, been abandoned. This observation is confirmed by the manner in which saxifragine burns in the open air. Ordinary powder spread on a stone and lighted ignites instantly, and rises in smoke, leaving only a little dust behind it; but saxifragine takes fire upon all the surface which it covers, makes no explosion, but burns with an immense vivacity, and developes an enormous quantity of gas, which is the cause of its great expansive power, and as it leaves behind it a certain blackish residue, it cannot be used for fire-arms. Moreover, saxifragine not being hygroscopic, it is easily preserved, and burns freely in the air without explosion, whilst at the same time it is not more dangerous to keep than tow, hay, or any other combustible matter. We understand that the parties interested in this matter in England have sent over an engineer to Belgium who, in company with the government officials of that country and officers deputed by the Russian and Swedish Legations at Brussels, has made experiments in the limestone quarries on the banks of the Meuse, and also in the granite quarries of Quenaste, which have proved very successful, and which tend to confirm the representations made to them by the inventors of the Saxifragine.

W. J. C.—Particulars received, and will be referred to in our next.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.

NEW SYSTEM OF MARINE PROPULSION.

On the night of Saturday, the 6th ult.. the ordinary monthly meeting of the above society took place. Mr. Joseph Newton, of the Royal Mint, President, occupied the chair on the occasion, and the main business of the evening consisted of an adjourned discussion of the merit of "Vailes' submerged and feathering endless chain propeller." The conclusion arrived at was, that the general principle of the invention was excellent. As to points of detail some members pointed out the necessity of modification, but it was admitted that a practical application of the scheme might prove that even these objections were not maintainable.

It was stated that a model of Mr. Vailes' propeller, on a rather large scale, might be seen at 22, Basinghall-street.

Mr. Newton, at the close of the discussion, referred in a very feeling manner to the painful position in which a series of accidents had placed Mr. Robert Armstrong, C.E. He rejoiced to think that their own Society endeavoured to raise a fund for the purpose of meeting such cases as that he had just name d, and he was sure that his fellow members would sympathise with Mr. Armstrong. The result was that Mr. Newton was requested to draw up a subscription paper to be laid on the table at the July meeting.

BOOKS RECEIVED.

Lessons and Practical Notes on Steam, the Steam Engine, Propellers, &c. By the late W. H. King, U.S.N., revised by J. W. King, Chief Engineer U.S.N. Fourth edition, enlarged. New York: D. Van Nostrand, 192, Broadway. London: Trubner and Co., Paternoster Row, 1863.

Results of an Experimental Enquiry into the Tensile Strength and other Properties of various kinds of Wrought Iron and Steel. By David Kirkaldy Illustrated by numerous plates and diagrams. Second edition. Glasgow Sold by the author at 4, Corunna-street. London: Hamilton, Adams and Co., Simpkin, Marshall and Co., Charles Griffin and Co.

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Schiele v. Brakell.—The plaintiff moved for an injunctiou to restrain the defendant from receiving, retaining, or opening any letters or letter addressed C. Schiele, or Schiele and Co., C. Schiele and Co., Platt and Schiele, or otherwise addressed to the plaintiff Christian Schiele, or the plaintiff's said firm of C. Schiele aud Co., and from availing themselves of these letters for tbeir own henefit. The bill alleged that the plaintiffs had carried on business as engineers and ironfounders at North Moor, Oldham, from 1851 till the autumn of 1852, under the style of C. Schiele and Co. The plaiutiffs were the only partners till the 5th November, 1856, when F. Schiele joined them, when the firm became Christian Schiele and Co. On the 1st July, 1859, F. Schiele retired. The business chiefly consisted in the manufacture and sale of articles for which Christian Schiele had obtained patents. Some time since the plaintiffs determined to confiue their business to the sale of the patented machines, and to grant liceuces for the use thereof. In the latter part of 1859, the plaintiffs agreed with the defendants to let them the premises, and to grant licences for the mauufacture of parts of the pateuted machines. The bill alleged that the plaintiffs' names were well known in the trade, and they had extensive connections. On the 1st September, 1859, a formal deed containing the terms of the agreement was executed. The hill alleged that the plaintiffs had discovered that the defendants had received numerous letters intended for the plaintiffs, and had executed orders contained in such letters, which, it submitted, referred to the plaintiffs' patented machinery, for which no licence had been granted. Under these circumstances the plaintiffs filed this bill. Mr. Kenyon and Mr. Hetherington, for the defendants, contended that they were entitled to receive such of the letters as were addressed to the firm of Schiele and Company, in respect of tbat part of the business which they had purchased. They denied having made any improper use of the letters they had received. The Vice-Chancellor said he thought the defendants had received some of the letters to which they had no right, one from India in particular, relating to Schiele's centrifugal pump. The plaintiff was entitled to the injunction as prayed in the 1st and 4th paragraphs of the bill.

Needham v. Oxley.—The Vice-Chancellor's Court was occupied for three days with a trial in this case, of certain issues as to the validity and novelty of the plaintiff's patent, and the alleged infringement hy tbe defendant of that patent. The plaintiffs in 1853 took out a patent for "Improvemeuts in machinery and apparatus for expressing liquid or moisture from substances," their invention consisting, as was alleged, of a new and original combination of portions of various processes for which patents either expired or existing had been already taken out. The patcnted machine was known as the "Patent Filter Press," and had been used to a considerable extent, especially in hreweries. The defendent, who was a brewer's engineer at Frome, Somerset, had constructed a yeast press for Messrs. Thorne, brewers, and for other parties. Tho yeast press at Thorne's brewery had been inspected by the plaintiffs, who thereupon came to the conclusion that the defendant had pirated their invention, and accordingly filed their bill in this court to obtain relief. A jury had been summoned to determine the questions of validity of patent and infringement, and the issues were in substance as follows:—1, validity of the patent of the plaintiffs, having regard to the specification; 2, novelty of invention; 3, infringement by the defendant. The trial of these issues occupied three whole days, and the witnesses, including several gentlemen of great scientific and engineering eminence, were numerous on both sides. The evidence was, however, of too technical a character to be given in detail. The defence was in substauce as follows:—That the provisional specification filed by the plaintiffs omitted several essential portions of the invention, and was materially different from the complete specification filed six mouths later in accordance with the patent laws; that the patent was bad for want of novelty, being merely an adaptation, with slight aud immaterial differences, of processes already known and in use; and lastly, that the defendant, by using parts included in the plaintiffs combination which bad been used, known, and published before, and by superadding several improvements of his own, so as to form a new combination, had not infringed the plaintiffs patent. The Vice-Chancellor, in summing up, observed upon the first issue that it was not necessary that the invention should have been perfected in all its details at the time when the provisional specification was filed. It must, no doubt, have been invented in the mind of the patentee. He must have made the discovery then, although the means of perfecting the discovery and making it available might not have been at that time completed. A distinction was drawn in the recent Pateut Act between the two specifications, the purpose of the provisional being to describe the nature of the invention, while the complete specification six months later must particularly ascertain and describe the nature of the invention, and, also, in what mauner the same shall be performed. The *onus* was not altogether upon the plaintiff's of showing that they had really invented that which they professed to have invented at the date of the provisional specification; but rather the jury must be satisfied that the plaintiffs had nothing of the kind in their minds at that time. If they came to this conclusion, then the verdict must be for the defendant upon the first issue. Upon the second question—as to novelty—it was for the defendaut to make out that the plaintiffs invention had been anticipated. Large sums had been paid for the plaintiffs' machines, and all the scientific witnesses, even those of the defendants, agreed that until the plaintiffs invention had heen brought into use they had seen nothing like it, although Billiter's and other patents had been taken out several years before that of the plaintiffs'. It had been said that the slightness of change was such that the plaintffs ought not to obtain the monopoly of a patent to the exclusion of otbers. But the real question was, whether the invention had been largely and practically useful; and he confessed that he thought there was a great amount of evidence in favour of the plaintiff's case in this respect. As to infringement by the defendant, he was not entitled to take the combination of the plaintiffs, even up to a certaiu poiut only, and then add additions or improvements of his own. That, he was bound to tell them, would be an infringement, and it was for them to consider upon the evidence how far the defendant had taken the plaintiffs' combination, merely making some additions; or whether he had, on the other hand, substituted an entirely different combination, in which case he would not bave infringed the plaintiffs' patent. The jury, after less than half an hour's deliberation, returned a verdict for the plaintiffs upon all tbe issues.

Damages against Railway Furnaces.—A case was recently tried at the Jury Court, Edinburgh, before Lord Bareaple, in which Messrs. Cooper and Wood, bottle manufacturers, Portobello, claimed £1000 damages against the North British Railway Company for injury sustained by the house and grounds of Baileyfield, Portobello (of which the pursuers are proprietors) from smoke, dust, and gases discharged from the defender's works for converting and hardening iron rails. The works in question were erected about three years ago on a narrow strip of ground left vacant between a curve formed for the improvement of the Leith and Portobello hranch line and the origiual railway track, and they were separated from Baileyfield only by the railway line and the Leith and Dalkeith road running alongside. The pursuers alleged that clouds of smoke and dust, as also deleterious gases, were constantly thrown out in large quantities from fonrteeu low chimneys, rendering the residenee at Baileyfield uuhealthy and unsafe, or, at least, uncomfortable, and drying up and wasting the trees, shrubs, and vegetatiou. It was accordingly put in issue whether the house aud grounds of Baileyfield were deteriorated by the defenders' works, and the comfort of the occupation impaired, to the nuisance of the pursuers and their loss, injury, and damage. A large number of scientific witnesses, including chemists, medical practitioners, architects, and horticulturists, were examined ou both sides. The evidence was to a very great extent conflicting, hut it seemed to be proved that the vegetatiou had, since tbe erection of the furnaces, been considerably injured, and that the comfort of the occupation had heen interfered with. The jury were divided in opinion, but by a majority of nine to three they found for the pursuers, with £200 damages.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with au epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with auy of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive cousiderable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Newcastle and Welsh Coal for Steam-Vessels.—The Northumberland Colliery proprietors have presented a memorial to the Lords Commissioners of the Admiralty with a view to secure the adoption of a mixture of South Wales and North Country coal

in the navy. They have made trial of various methods of obviating this objection; and, amongst others, have ascertained that when burned in company with the steam coal of Wales, in equal portions, or even with one-third of the quantity composed of Welsh coal, no smoke is emitted. In forwarding the memorial to their lordships, Mr. W. S. Lindsay observed—"Though I have no interest, directly or indirectly, in any of the coal mines, yet I consume a considerable quantity of coal in my steam-ships, and my firm are large shippers of coal for the use, at distant stations, of the Peninsular and Oriental, and other large steam-shipping companies. I can, therefore, state from my own knowledge, that North and Welsh coals mixed are used to a very large amount, and are also found to answer the purpose named in the memorial. I may further add, for the information of the Lords Commissioners of the Admiralty, that in the tenders for the Peninsular and Oriental Company the proportions—two-thirds of North of England coals and one-third of South-Wales. The coals from South-Wales, though in use at the Mediterranean stations, are not used by that company at any of their stations in the East Indies or in China, on account of their rapid deterioration when stored." In reply to this, Mr. W. G. Romaine writes, "that he has been commanded by the Lords Commissioners of the Admiralty to acquaint you that they have ordered experiments to be made on board several small steam-vessels at home parts, to ascertain the practical results of using North Country coal in combination of Welsh coal."

SHIPPING.—A parliamentary return has been issued exhibiting the number and tonnage of vessels employed in the trade of the United Kingdom in the year 1862. The number of British vessels entered "inwards" was 29,554 and the tonnage 7,856,639; and the foreign vessels were 25,906 in number, and the tonnage 5,234,451. The vessels cleared "outwards" were —British: 29,530 of 8,090,221 tonnage; and the foreign vessels were 26,679 in number, of 5,354,128 tonnage. The return also shows that during the year the number of vessels built in the United Kingdom and British possessions was 1215 of timber, of 231,808 tonnage; and of iron, 63, of 40,596 tonnage. The steam vessels of timber were 46 in number, of 2387 tons; and of iron, 158, of 66,082 tons. The number of vessels wrecked in the year, belonging to the United Kingdom, were—sailing vessels, 638, of 154,768 tons; and steam vessels, 36, of 17,468 tons. The number of vessels registered in the United Kingdom as new ships, during the year, was, of timber, sailing vessels, 991, of 228,378 tons; and of steamers 40, of 1016 tons. The iron sailing vessels were 70 in number, of 44,047 tons; and the steam ships 181, of a tonnage of 77,986.

EXPERIMENTS WITH PETROLEUM.—At a recent meeting of the Liverpool Dock Board, a report of the Marine Surveyor on some experiments made with petroleum was read. From this it appeared that the oil burned for ten minutes, giving a good flame, when an explosion took place, blowing the lamp to pieces. The lamp used was the ordinary lighthouse lamp, as at present in use, and the explosion is partly to be attributed to the fact that the lamp in question was unsuited for the description of oil to which it was applied; but partly also, to neglect of testing the oil, and the use of too volatile a quality of it. The degree of heat, however, may be so great as to render all such oils improper for such a purpose.

THE POWERFUL HYDRAULIC PRESS for bending armour plates, manufactured by Messrs. Westwood, Baillie, and Co., for Her Majesty's dockyard at Pembroke, underwent an official trial on the 9th ult. The press is a duplicate of the one erected a few weeks ago in Woolwich dockyard. Two plates of 4½in. and one of 3in. in thickness were placed on the ram cold, and were subjected to a pressure of 46½ cwt. per circular inch of the ram, which is equal to a pressure of 1823 tons, being the greatest pressure yet obtained by any machinery. All the joints of the pumps and press were perfectly tight. The plates bent were 3ft. 3in. wide, and were curved 1¼in. in the width. Two plates, one 4½in. thick and one 3in. thick, were then turned over and placed in the press with the 1¼in. curved side downwards, and by working the press up to 24 cwt. per circular inch, or 940 tons on the ram, the plates were bent 2½in.—viz.. from 1¼ hollow to 1¼ round in the width. The same firm are manufacturing three similar presses for the Russian Government, and also the huge iron rudder, to weigh 13 tons, for Her Majesty's 30 gun iron steam ship *Achilles*, 6079 tons, building at Chatham.

STEAM TRUMPETS.—It appears that these instruments are the invention of a Dr. Upham, of Boston, U.S. About a year ago he obtained the use of two locomotives for the purpose of an experimental talk by the sounds of the steam whistle. The inventor had attached several contrivances to the whistle in the shape of bells, trombones, and clarionets, and by means of these he was enabled to represent the sounds of the alphabet by very different sounds. He found that by their means he could convey a message to a distance of three miles, which could be heard and understood even amid the more immediate sounds produced by the movement of a railway train. The doctor has, it is said, found it possible, by the simple trumpet, to transmit any message, however long or complicated, the distance of a mile.

RAILWAY TRAVELLING.—Dr. W. Lewis, the medical officer of the London Post-office, states in his report just issued that he has arrived at the following conclusions from observations of the health of the travelling-officers of the Post-office,—That railway travelling has little, if any, injurious effect on healthy, strong, well-built persons, if the amount be not excessive, and if they take moderate care of themselves;—but that persons who take to habitual railway travelling after the age of twenty-five or thirty are more easily affected than those who begin earlier, and that the more advanced in age a traveller is the more easily is he affected by this sort of locomotion. Weak, tall, loosely-knit persons, and those suffering under various affections, more especially of the head, heart, and lungs, are very unsuited for habitual railway travelling.

IRON CASTINGS.—From experiments conducted at Brest by M. le Guen, it is found that castings containing a small percentage of woolfram are far superior to those of the ordinary kind; the principal advantage conferred being increased elasticity.

THE MAGNETO-ELECTRIC LIGHT AT DUNGENESS.—Some further reports on the progress of this "magnificent" light, as the committee of the Trinity House have called it, have been printed by order of the House of Commons. In one, dated April 8th, 1863, the secretary says :—"The light has now been exhibited at Dungeness for the period of nine months; and during that time has, with some brief exceptions (generally attributable to want of care on the part of the attendants), been maintained without break or failure, showing a light of exceeding power and intensity, which Mr. Faraday, who took as his standard the revolving light at Grisnez, with which, at equal distances it was of equal power, estimated to be eight times that of a first order fixed dioptric light (see his report No. 1). Every part of the machines and engines has worked well, although one of the boilers has just required repair, causing a pressing demand from the engineer for the third spare boiler, which he has suggested as necessary. The lamps and lenses have been gradually improved until they may now be said to be perfectly satisfactory, and have been under the charge of the ordinary light-keepers, possessing no more than the usual ability of such persons. The engines and machines have been under the charge of two engineers." Various minor objections, however, to the light as it exists, are stated in these reports; but some of these are vitiated by the discovery that the chief engineer has had to be dismissed on account of intoxication. Professor Holmes replies satisfactorily to the objections in a separate pamphlet, and Professor Faraday also discusses some of them. The light seems to be visible at from twenty to thirty miles' distance, but occasionally not so far, a circumstance which Professor Faraday ascribes on certain occasions to local haze. The Trinity House authorities, however, admit the superior advantages of the light in respect to penetratrative power and star-like brilliancy, although other first-class lights they regard as practically sufficient.

NAVAL ENGINEERING.

THE "ORLANDO," 46, Captain G. G. Randolph, was put out of dock at Chatham on the 4th ult., after having undergone very extensive repairs. In order to strengthen her stern two iron plates, each weighing five tons, have been fixed under her quarters, and strong iron knees and bracings, and to those parts of her keel and sides which gave indication of weakness when her powerful engines of 1000 horse power were at full speed. The immense weight of metal put on her stern only brought her down half an inch. After she has shipped her guns and powder, she will proceed to join the North American squadron.

THE "RESISTANCE," 16, screw iron frigate, in No. 10 dock at Portsmouth, has been officially examined and reported upon by the Master Shipwright and his staff relative to the condition of her bottom plates, which when the ship was last in dock were coated on opposite sides with the composition of Mr. Hay, the chymical assistant at Portsmouth dockyard, and that of Messrs. Peacock and Buchan, as applied to the bottoms of steam-ships of the Peninsular and Oriental Company. The ship has since then been afloat less than seven months, and, considering the time, both sides of her bottom are foul; one, however, is much more so than the other, and is also more covered with barnacles. The starboard side has long grass in the wash of the waterway at the bow and quarter, and the remainder of that side at the bottom is studded with small tufts of grass averaging one inch in length, and from three to four inches apart. There are also a few patches of barnacles where the composition has been disturbed, but in very few other places; and there are very few spots of corrosion. The port side has the same description and length of grass at the bow and quarter, and the same description of short tufts of grass, studded at about the same intervals, but it has more adhesive matter altogether on the opposite side. The surface of the composition from the keel to the bilge plate amidships is thickly studded with barnacles. This having been the working anchor's side, there is the usual amount of corrosion to be seen on the bow from the abrasion of the composition by the chain cable, which must always attend the use of copper anti-fouling compositions on the bottom of iron ships.

THE ESK, 20-gun screw corvette, made her official trial of speed at the measured mile in Stokes Bay, on the 12th ult. She drew 16ft. 4in. of water forward, and 18ft. 2in. aft.; was complete in stores of all kinds for sea, and had 270 tons of coal on board. Six runs at the measured mile with full boiler power gave results consecutively as follows :—10·315, 8·181, 10·716, 8, 10·975, and 7·875 knots. The *maximum* revolutions of the engines were 70 and the *minimum* 68, with a 20lb. pressure of steam and 24 inches vacuum. With half-boiler power four runs were made at the mile, the speed in each case being, 9·278, 7·453, 8·633, and 6·977 knots, the mean speed of the ship during the four runs being 8·2 knots. To test the engines they were stopped in seven seconds from the time of moving the telegraph, were started ahead under the same conditions, in 10 seconds, and were moved astern in 18 seconds. The screw the Esk is now using is a common or Admiralty pattern, having a diameter of 12 feet, a pitch of 9 feet 8 inches, and a length of 3 feet.

THE "COSSACK," 20-gun screw steam corvette, 1296 tons, 250-horse power, made her official trial of speed at the measured mile off Maplin Sands on the 13th ult., prior to leaving for the Mediterranean. Six runs at full speed, with full boiler power, were made on the mile, which gave an average of 9·055 per hour, the pressure of steam being 20lb.; vacuum, 25; revolutions of engines at full boiler power, 80; at half-power, 56. Two runs were made at half boiler power, giving an average of 5·945 knots per hour. The circle was turned with helm to port in 5 min. 29 sec., and with helm to starboard in 6 min. 12 sec. The *Cossack* is fitted with Smith's propeller; diameter, 12ft. 1in.; pitch, 16in., and the immersion of screw was 2ft. 8in. At the time of the trial the draught of water was 17ft. 7in. forward, and 17ft. 8in. aft. The engines are from the eminent firm of Maudslay, Son, and Field.

THE IRON-CLAD FRIGATE "ROYAL OAK.—The performance of this vessel in the run from Chatham to Spithead is described as being in the highest degree satisfactory. After leaving the Nore, all the fires were lighted, and the vessel was put at full speed, when, notwithstanding a strong head wind (force 5 to 7) and a heavy rolling sea, the iron-clad attained a speed of 11 knots an hour, and that too against a strong breeze. The *Royal Oak's* steering qualities are described as excellent. Although the sea broke completely over her bows in the run down channel, she exhibited scarcely any pitching or rolling. The ventilation of the ship gives the most complete satisfaction, the engine-room, together with the aft and forward stoke-holes, having remained very cool. The official trial of this, the first of the converted and fully armoured frigates, commenced on the 15th ult., at the measured mile, at Stokes Bay. The engines of the ship are of 800-horse power, nominal, by Messrs. Maudslay, Field, and Son, and are from the same patterns, with the exception of some minor improvements in their detail, as those of Her Majesty's ship *Marlborough*. They are on the horizontal principle, with direct action, and have cylinders of 82in. diameter with a 4ft. length of stroke. The fire grate surface is 565 square feet, the heating surfaces in furnaces and flue is 2100 square feet, and the heating surface of the tubes is 13,300 square feet. The weight of the engines is 186 tons, of boilers 206 tons, and of water in boilers when filled 118 tons. The coal boxes have a measurement of 21,480 cubic feet. and stow 600 tons of coals—seven days' consumption. The propeller is a Maudslay-Griffiths, weighing 11 tons 11 cwt. It is 19ft. in diameter, with a length of 3ft. 10½in., and is set at a pitch of 27ft. 6in. It has a varying pitch down to 22ft., but to alter the pitch at any time the ship must be placed in dock, as the screw has been made a fixture, in this following the example of the French Imperial Marine. The following are the results of the trial at full boiler power:—

No. of Run.	Revolutions of Engines.	Time. min. sec.	Speed of Ship in Knots.	Pressure of Steam.	Vacuum.
1	59	4 55	12·203		
2	61½	4 40	12·[illegible]		
3	61	4 [illegible]	12·557	22 [illegible].	22½in.
4	61	5 2	11·920		
5	61½	4 30	13·[illegible]		
6	61	5 0	11·[illegible]		

First mean speed in knots, 12·351, 12·678, 12·388, 12·626, 12·941; second mean speed in knots, 12·514, 12·533, 12·507, 12·658. Mean speed of the ship, 12·528 knots. It is as well here to place in juxta-position the temperatures of the engine-room and stokeholes at this time, as we have referred at some length to the great want of ventilation in ships coated with armour all round, and the means which have been taken to remedy this evil in the *Royal Oak*. In making the first run at the mile, the temperatures were recorded as follow:—On deck, 58°; in engine room, 73°, 73°, and 70°; in the forward stokehole,—fore part, 84°; middle, 100°; and after part, 113°; in after stokehole—fore part, 103°; middle, 105°; and after part, 105°. In the sixth mile run they were as follow:—On deck, 60°; in engine-room, 72°, 72°, and 75°; in forward stokehole—fore part, 91°, middle, 120°; and after part, 112°; in after stokehole—fore part, 102°, middle, 101°; and after part, 104°. The speed attained by the *Royal Oak* was considered in the highest degree satisfactory in all the sense of the words, if it is considered that the ship's "official" estimated speed was set down at 11½ knots, and that she actually exceeded that rate by one knot an hour. On the 16th ult. the ship was tested in her power of turning and completing circles under full steam. On reaching the desired position, however, a hot bearing was discovered,—the full speed circles had to be abandoned, and the ship's trials for the day were cut down to six runs, with two boilers (one-third of the

ship's boiler power), and two circles afterwards with the same power. The runs were made as follows:—

No. of Runs.	Time. min. sec.	Speed of Ship.	Revolutions of Engines.	Pressure of Steam.	Vacuum.
1	8 19	7·214	35½	22	24
2	7 43	7·775	40¼	22	23
3	6 49	8·801	37½	19	24½
4	8 26	7·114	38¾	22	23
5	6 46	8·867	39	22	24
6	8 43	6·883	38	22	24

Mean speed of the six runs, 7.979 knots. The circles were made under the same conditions of power, and yielded the following results:—

	Circle to Starboard.	Circle to Port.
Time occupied in getting up the helm	47sec.	30sec.
Angle of rudder	26deg.	29½deg.
Turns of wheel	3½	3¾
Time occupied in making half circle	3min. 42sec.	3min. 43sec.
Ditto full circle	7min. 27sec.	7min. 50sec.
Revolutions of engines previous to putting up the helm	37	37
Revolutions afterwards	35	34½
Men at the wheel	7	8

The diameter of the circles were little over twice the ship's length. The Royal Oak resumed and concluded her trials on the 17th ult. The following is the result of the trial with four boilers, or two-thirds of the ship's power:—

	1st circle to port.	2d circle to port.	Circle to starboard.
Time occupied in getting up the helm	1′ 0″	1′ 25″	1′ 32″
Angle of rudder	25°	28°	26°
Turns of wheel	3½	3½	3½
Time occupied in making half circle	3′ 7″	2′ 58″	2′ 58″
Ditto full ditto	6′ 21″	6′ 6″	5′ 44″
Revolutions of engines before helm was up	48	52	50
Ditto after ditto	43	47	48
Men at wheel	6	6	6

These three circles being considered a sufficient test of the ship's steering power under two-thirds force of her boilers, the ship was steered in for Spithead, and placed on the trial ground in Stokes Bay, to make four runs at the mile with the same amount of boiler power. The results of the four runs were thus.—

No. of run	Time. m. s.	Speed of ship.	Revolutions of engines.	Pressure of steam.	Vacuum.
1	4 51	12·371	51½	23	24
2	6 0	10·000	53	23	23½
3	4 53	12·287	51	23	24
4	6 8	9·783	52	23	24

Mean speed of the ship at two-thirds power, 11·126 knots.

Steam was next got up in the remaining two boilers, and two circles made with the ship's full boiler power:—

	First circle to port.	Second to starboard.
Time occupied in getting up the helm	1′ 30″	1′ 31″
Angle of rudder	26½°	22°
Turns of wheel	3¼	3
Time occupied in making half circle	2′ 47″	2′ 47″
Ditto full circle	5′ 27″	5′ 23½″
Revolutions of engines before helm was up	62	60
Ditto after ditto	55	53
Men at wheel	6	6

With the exception of testing the facility with which the machinery could be worked in answer to the engine-room telegraph, the ship's official trials were now concluded, and these closing tests gave their returns as follows:—Engines stopped dead, from time of moving telegraph handle, in 55 sec.; engines working astern at full speed from rest, ditto, in 18 sec.; engines from full speed astern to full speed ahead, from ditto, in 13 sec. The indicated horse power of the *Royal Oak* on her full boiler power trial of speed at the measured mile, was 3704 horses, and on her four boiler power trial (two-thirds of her boiler power), 2298 horses. It is a remarkable fact that the *Royal Oak's* trial of speed at Portsmouth, with all her guns, stores, provisions, &c., on board,—in fact, ready for sea, should have exceeded in speed that obtained in her light-draught full-power trial off the Maplin Sands, yet such is the case. At Portsmouth she drew 23ft. 8in. forward, and 25ft. 7in. aft. Off the Maplin Sands she drew only 20ft. 4in. forward, and 23ft. 1in. aft. This gives a difference of about 900 tons in the ship's displacement, and yet a greater speed was obtained by the assistance only of a few pounds of steam.

TRIAL OF THE "ROLF KRAKE," A DANISH CUPOLA ARMOUR CLAD.—This new Cupola screw armour clad man-of-war, built by Messrs. R. Napier & Sons, Glasgow, for the Danish Navy, recently underwent her trial trip, which was in every way satisfactory. The *Rolf Krake* is of peculiar construction, being low in the water, and of considerably greater breadth than is usual for vessels of her length. She is built from plans approved by Captain C. P. Coles. Her length is 185ft.; breadth 33ft.; depth 14½ft.; tonnage 1246 tons. Her engines are of 240 horse power. She is only some 5ft, above the water line, with bulwarks to fold down in action, and she displays two revolving cupolas rising 4½ft. above the deck, and 21ft. in diameter. She is armour plated from stem to stern, the plates being 4½in. in thickness, and increasing to 7½in. at the port holes, with the addition of 9in of teak lining inside. Her armament will be four 68 pounders, two in each tower worked from the inside. The deck is entirely clear of obstruction, except the funnel and a small fixed tower aft for steering the vessel.

TRIAL OF THE "COLUMBINE."—The screw steam gun vessel *Columbine*, 4 guns, 669 tons, for service in the Channel Fleet, has undergone the official trial of her engines at the measured mile off Maplin Sands. The vessel made six runs at full speed on the measured mile. The following were the results:—Average speed 9·504 knots per hour, revolutions of engines *maximum* 107, mean 103·5, pressure of steam 23lb., vacuum 23. Four runs were made at half-boiler power, with an average speed of 7·541 knots per hour, the revolutions of engines being *maximum* 88, mean 80·5, vacuum 25, pressure of steam 20. The *Columbine* is fitted with direct action horizontal engines of 150 nominal and 600 indicated horse-power. She has a Griffith's screw, the pitch of which is 13ft., and the diameter 10ft., supplied by the Greenock Foundry Company. During the trial the machinery worked in a most satisfactory manner, there being no priming or hot bearings. At full speed, with helm to starboard 21½ degrees, the time of turning the circle was 4 min. 12 sec., the diameter of the circle being 238 yards; with helm to port 22½ degrees the time taken was 4 min. 29 sec., the diameter being 318 yards. At half speed, the helm to starboard 25 degrees, the time was 4 min. 27 sec., the diameter 212 yards: helm to port 21½ degrees, the time was 4 min. 59 sec., the diameter being 318 yards. The trial was considered most satisfactory.

NAVAL APPOINTMENTS.—The following appointments have taken place since our last, W. Hardie, Engineer, supernumerary to the *Asia*; J. Gray, First-class Assist. Engineer-to the *Fisgard*, as supernumerary; J. West, First-class Assist. Engineer, to the *Columbine*; R, Sampson, Chief Engineeer, and H. J. Hall, Assist. Engineer, to the *Indus*, fo; the *Prince Consort*; T. R. Butters, Assist. Engineer, to the *Victory*, for the *Sprightly*. H. D. Garwood and F. Moore, Assist. Engineers, to the *Asia*, for the *Enchantress*; F. W. Suthon, (B) Engineer, to the *Indus*, as supernumerary; E. Fowell, acting Engineer, to the *Orlando*; T. Catchpole, Assist. Engineer, to the *Asia*, for the *Charger*; T. Scott, (B) Asist. Engineer, to the *Cumberland*, as supernumerary; J. Legabe, Assist. Engineer, to the *Edinburgh*, for the *Tender*; B. Barber, Chief Engineer, to the *Cumberland*, for the *Salamander*; W. Pitt, Chief Engineer, and P. Samson, Assist. Engineer, to the *Indus*, for the *Sanspareil*; H. J. Iles, Assist. Engineer, to the *Cumberland*, as supernumerary; F. C. Ford, Assist. Engineer, to the *Indus*, for hospital treatment; J. Wylie, of the *Valarous*, W. Frazer, of the *Indus*, P. Eckford, of the *Asia*, W. Pearson, of the *Emerald*, and T. Scott, of the *Cumberland*, promoted to First-class Assist. Engineers; J. R. Robinson, of the *Scout*, J. M'Gough, of the *Surprize*, F. Pointon, of the *Orontes*, J. Crawford, of the *Mutine*, R. Wyllie, of the *Bustard*, A. Leitch, of the *Kestrel*, and W. Barclay, of the *Medea*, promoted to acting First-class Assist. Engineers; J. Orchard, in the *Syrian*, promoted to Engineer; E. L. Williams and P. Murray, in the *Asia*, and J. Wilson, in the *Echo*, promoted to First-class Assist. Engineers; W. Read and J. Croll, Assist. Engineers, to the *Dasher* and *Racoon*, respectively; J. Orchard, in the *Tyrian*, promoted to Engineer; E. L. Evans and P. Murray, in the *Asia*, and J. Wilson, in the *Echo*, promoted to First-class Engineers; W. Read and J. Croll, Assist. Engineers to the *Racoon* and *Dasher* respectively; C. F. B. Hurt and J. Parry, Assist. Engineers to the *Indus*, as Supernumeraries; J. W. E. Baron, Assist. Engineer, to the *Asia*, as supernumerary; W. H. Sedgwick, Assist. Engineer, to the *Himalaya*; R. Stevens and C. E. Williams, to the *Ajax* and the *Dee* respectively; A. H. Symes, Assist. Engineer, to the *Fisgard*, as supernumerary; W. B. Cleverly, Assist. Engineer, to the *Excellent*, for the *Stork*.

MILITARY ENGINEERING

TESTING ARMOUR PLATES.—In the course of some experiments which took place at Portsmouth, between the 3rd and 6th ult., to test the resisting powers of various kinds of armour plates, six made by the Butterly Company, at Alfreton, Derbyshire, were subjected to seven shots each, under the same conditions as the plates by other makers. These plates were all 4½in. in thickness, and varied from 8ft. to 13ft. in length, and from 3ft. 6in. to 4ft. in width. Five of the plates were struck twice in the same spot, but none were penetrated, and so far as substantial protection to anything behind them were concerned, were not injured. The results were satisfactory.

STEAM SHIPPING.

TRIAL TRIP OF THE LORD GOUGH.—This paddle steamer, recently launched on the Clyde by Messrs. Caird & Co., for the Dublin and Glasgow Steam Packet Company, underwent a trial trip on the 15th ult., of which the following is the result:—During the run the engines averaged 29 revolutions, with a pressure of 27½lbs. on the square inch. They worked smoothly and without heating, the average rate being 14½ knots or 16¾ statute miles per hour. The dimensions of the *Lord Gough* are;—Length of keel and forerake 232ft.; breadth 26ft.; depth 14ft. 9in.; and tonnage 765 o.m. She is propelled by a pair of oscillating engines, furnished by the builders, of 270 horse power nominal, having 63in cylinders, with 6½ft. stroke, and fitted with patent expansion valves, the invention of Mr. J. T. Caird, These enable the engineer to cut off the supply of steam when the piston has reached any part of its stroke, thus enabling the pressure of steam in the boiler to remain at a high density, and have all the advantage in oscillating engines of expansion.

THE "WINANS" STEAMER.—The Winans, a steamer constructed at Baltimore on the cigar-shaped principle, has arrived at Hull to be lengthened. She is at present 80ft. long, and in the widest part amidships is 8ft. in diameter. On the top or back of the vessel there are four short tubes projecting about two and a half feet, which will answer the purpose of ventilators, and as a means of entrance to the vessel. To prevent the steamer rolling over in the water, she is well ballasted with spelter, and draws about 3ft. of water. There are several screws in her sides, to which stanchions may be fastened. On this a grating to form a deck is fixed, and an iron guard runs from stem to stern. The vessel is propelled by means of a screw, which is placed about 20ft. from the stern.

AUSTRIAN STEAM NAVIGATION.—A new Austrian Steam Navigation Company is in course of organisation. The principal promoters are the Prince Colloredo-Mansfield, Baron Dobloff, Baron de Hohenbruck, Prince Jablonowski, and Herr Louis Merteus. The capital of the company has been fixed at £2,000,000, and this considerable sum is stated to have been subscribed for. The objects at which the new company is to aim are the following:—First, the carriage of passengers and goods between the Mediterranean and the Eastern coast of America; second, of the establishment of yards for the construction of ships on a great scale at Trieste: and thirdly, the improvement of the port of Trieste, and the construction of docks and warehouses.

IRON SHIPBUILDING ON THE MERSEY.—Iron shipbuilding is in a very active state at Liverpool, twenty-three vessels being at present in progress in the yards of the various builders. Messrs. Laird have on hand a large steamer of 700 tons for the London and North Western Railway Company, and two ships of 1000 tons each for Messrs. Clint. Messrs. Royden have two ships of 1000 tons each for Messrs. C. Moore; and another for Messrs. Fletcher. Messrs. Hart and Simmott have two ships of 1000 tons each in hand for Messrs. Finlay, Campbell, and Co. Messrs. Patterson have a vessel of 750 tons, for Messrs. Boult, English, and Brandon, in course of construction. Messrs. Vernon have the following:—One of 1166 tons for Messrs. Potter Brothers, just launched; one of 900 tons for Messrs. W. J. Myers and Co.; one of 800 tons for Messrs. Imrie and Tomlinson; and one of 900 tons for Mr. Liston Young. Messrs. Jones and Quiggan are busy, having no less than five vessels on the stocks; one of 1000 tons for Messrs. Semmell and Co.; one of 1194 tons for Messrs. Curry, Kellock, and Co.; one of 900 tons for Messrs. Copeland Brothers; one of 630 tons for Messrs. Blythe Brothers; and one of 630 tons for Messrs. H. T. Wilson and Chambers. Messrs. W. Miller and Co. have in hand a ship of 600 tons for Messrs. Prowse and Co., and two barques; and a small steamer of 60 tons for Messrs. Finlay, Campbell, and Co. Mr. Glover has a ship of 1050 tons for Messrs. Boult, English, and Brandon, in course of construction. Messrs. Laird have also on hand, in addition to the vessels already mentioned, two gunboats for the Emperor of China, about whose ultimate destination a good deal has been said, and an iron-plated frigate for the home Government. The ships which Messrs. Boult, English, and Brandon are having constructed are intended for the Calcutta trade, and are designated the "Shire" line. Three of the line—the *Staffordshire*, the *Derbyshire*, and the *Monmouthshire*—are completed.

STEAM SHIPBUILDING ON THE CLYDE.—Messrs. W. Denny and Brothers, of Dumbarton, have contracted to build two large paddle steamers, to be employed on the Yang-tze river, in China. One of these vessels is to be built for Messrs. Gibb, and is to be 1460 tons burden, with engines of 350-horse power; and the other, for Messrs. Jardine, Matheson, and Co., is to be 2040 tons burden and 450-horse power. The steamers are to be similar in design to the *Rona*, built last year by the same firm for the same trade for Messrs. Jardine, Matheson, and Co. The steamers, *Roe* and *Fox*, building by Messrs. Caird and Co., of Greenock, for the Clyde and Belfast line, have been sold and Messrs. Caird and Co., have received orders to proceed with two others in their stead. The owners of the Montreal Ocean Steamship line have contracted for another vessel, to be named the *Moravian*, of similar dimensions and power to the *Peruvian*, now under construction, and about to be launched for the same company. The dimensions of these steamers are

—extreme length, 320ft.; breadth of beam, 38ft. 3in.; depth of hold, 26ft. 3in.; giving a measurement of 2600 tons. The cylinders of the engines will be 6ft. 3in. in diameter. Among recent launches may be noted a paddle, built by Messrs. W. Denny and Brothers, of Dumbarton, and intended to be employed for towing purposes on the Hooghly. She is 450 tons burden, has engines of 250-horse power, and is the property of Messrs. Gladstone, Wyllie, and Co., of Calcutta. Messrs. Henderson, Coulborn, and Co., of Renfew, have launched a screw named the *Alerta*, intended for the Spanish trade. She is about 850 tons burden, and is now being fitted with diagonal engines of 150-horse power. The owners of the Montreal Ocean steamship line recently contracted with Messrs. Steele and Co., of Greenock, for two large steamers of 2,500 tons burden. The cylinders of the engines, which are to be of 400-horse power, will be supplied by Messrs. Macnab and Co., Shaw's Water Foundry, and will be 6ft. 3in. in diameter. Messrs. Steele have on hand a screw of 400 tons and several iron sailing vessels. Messrs. Caird and Co., have received an order from the West India Royal Mail Steamship Company, for a screw of 2434 tons burden and 500 horse power. The machinery will embrace surface condensation, superheated steam, and a steel shaft by Krupp, of Essen. The steamer will be modelled generally after the *America*, lately fitted by Messrs. Caird and Co. Mr. A. Denny, of Dumbarton, has launched an iron paddle named the *City of Dunedin*, built for the New Zealand coasting trade; she is 463 tons burden, and is to be fitted by Messrs. Denny and Co., with engines of 100 horse power. Messrs. Scott and Son, of Cartsdyke, have launched the *Washington*, a fine steamer of 3250 tons, builders' measurement, constructed for the Compagnie Générale Transatlantique. The *Washington* is 346ft. long, from bow to stern (her bow being a perpendicular one), and her breadth of beam is 44ft., while she has 31ft. depth of hold. She is now being fitted with engines of 850 horse power nominal, the diameter of her cylinders being 94in. Great things are expected of this fine vessel. The *Washington* is intended to ply between Havre and New York, being one of a fleet of 11 steamers now building for the same company—seven of the 11 are in course of construction by Messrs. Scott and Co., who have several of them on hand in France, and two others at their works at Cartsdyke. Each of the boilers and sole plates will weigh 61 tons.

TRIAL TRIP OF THE "ITALIA."—The trial trip of the *Italia*, the first steamer of the re-organised London and Mediterranean Steam Navigation Company, took place on the 24th ult., in the Lower Hope. The engines are by Messrs. Maudslay, Sons, and Field, and are of the same pattern as those of the *Royal Oak*. The speed attained during the trial at the measured mile, gave an average of $11\frac{1}{2}$ knots, or 14 statute miles per hour.

THE "CITY OF LONDON," IRON STEAM VESSEL, built by Messrs. James Ash & Co., of Millwall went down the Thames to the Nore and back, on her trial trip on the 6th ult., and also to test the superiority of Lumley's improved rudder. It is the first iron vessel fitted with this invention. The *City of London*, starting from Blackwall pier, with her her head up the river and her helm a few degrees to starboard, described a half-circle to bring her head down the river in 53 secs. During her passage she gave perfect satisfaction to the various scientific men who accompanied her. She accomplished the measured mile at the rate of 13·2 section miles per hour, and thus proved herself an exceedingly fast vessel. The engines are by Mr. J. Stewart, of Millwall; and the vessel is fitted with patent floats, steam windlass, Graham's patent tiller, and other modern improvements.

THE "SOUTHERNER," built for Messrs. Fraser, Trenholme & Co., of Liverpool, underwent a trial trip from Hartlepool Bay on the 3rd ult. The *Southerner* is an iron screw steamer, 310ft. long from figure head to stern, and 38ft. broad amidships; registered tonnage 2090 tons. Her engines, made by Messrs. Fossick & Hackworth, of Stockton-on-Tees, have direct action, 300 horse power, fitted with superheating and feed heating apparatus; the diameter of the cylinders is 40in., and length of stroke 33in. The speed attained was $12\frac{1}{2}$ knots, the engines working with great ease, considering this was the first time of trial.

STEAM TO BRAZIL AND RIVER PLATE.—A new commercial line of steam ships to Brazil and the River Plate has been organised to sail from Liverpool, and will commence on the 7th of August next. The first vessel will be the *Sicilia*, a screw steamer of 1125 tons, and 360-horse power. Her ports will be Rio de Janeiro, Monte Video, and Buenos Ayres. The charges both for freight and passengers are to be moderate, and it is stated that the *Sicilia* can make the run, if necessary, to steam all the way, without having to call anywhere to coal, and that as her consumption of coal is small in proportion to her capacity, she may accomplish the passage in twenty days to Rio and twenty-four to the River Plate.

LAUNCHES OF STEAMERS.

LAUNCH OF THE "TYNE."—This vessel was launched from the iron shipbuilding yard of Messrs. J. Wigham, Richardson, and Co., Low Walker, on the 6th ult. She is the property of the Shields Steam Shipping Company (Limited). The dimensions of the vessel are—Length, 180ft.; breadth, 27ft.; depth, $16\frac{1}{2}$ft. She will be propelled by a pair of engines 70 horse power (cal.), 34in. cylinders, 26in. stroke, which, with a tubular boiler of large capacity, it is expected will realise a speed of from eight to nine knots. She is classed at Lloyds, fitted with water ballast in double bottom, is to have a steam crane, Turpie's patent reefing gear, &c. Besides coal in bunkers, she will take 700 tons cargo in hold, on an easy draught of water. After her launch she was towed to Newcastle, where notwithstanding the inclemency of the weather, all her machinery, which was supplied by Messrs. R. and W. Hawthorn, was placed on board, and connectings made good, when she returned down the river under her own steam, the same evening, and was safely moored at the builder's yard, within 14 hours from her launch.

THE "OUSE" screw steamer, intended to ply as a passenger boat between Hull and York, has been launched from the yard of Messrs. Fowler & Co., Hull. She will be propelled on a new principle, having two screws, the blades of which will work within each other. Her engines are of 26 nominal horse power, and she is fitted with surface condensers. Her dimensions are,—length 84ft., beam 20ft., depth 6ft. 6in., registered tonnage about 140 tons.

THE "BOLIVAR" screw steamer was recently launched from the yard of Messrs. Richardson and Co., South Stockton. Her dimensions are.—Length over all, 247ft. 6in.; extreme breadth, 32ft. 6in.; depth of hold, 19ft. 6in.; and 1240 tons, old measurement. Her engines, which are of 160 nominal and 630 effective horse power, were from Messrs. Thompson and Co., Newcastle-on-Tyne. The *Bolivar* is intended to run between Liverpool and the West Indies.

LAUNCH OF THE "GREAT VICTORIA."—On the 10th ult. this steamer, originally known as the French steamer *Jacquard*, and which has been considerably enlarged and rebuilt, was launched from the yard of Mr. William Patterson, of Bristol. The *Great Victoria* is a steamer of magnificent proportions, being of 2800 tons, built for Messrs. James Baines and Co., of Liverpool, and intended to run in conjunction with the *Great Britain* between that port and Melbourne. Mr. Patterson is engaged building three other iron vessels of about 2000 tons burthen for the same firm.

LAUNCH OF THE "NORMANDY" LONDON AND SOUTH WESTERN RAILWAY COMPANY'S STEAMER.—The launch of the London and South Western Railway Company's new iron paddlewheel steamship Normandy took place on the 17th ult., at Messrs. James Ash and Co.'s yard, in the Isle of Dogs. The launch was highly successful. When it was over the vessel was taken in tow, and brought round into Mr. J. Stewart's yard, to be fitted with her machinery of 225-horse power. The engines will be supplied with improved condensers, arranged with separate cylinders, so that a vacuum can be maintained without the assistance of the main engines, which are solely employed to propel the vessel. The boilers are of large size, fitted with brass tubes. The paddles are of the feathering description, and the engines are fitted with the peculiar link motion applied to work the slide valves, so as to enable one man to start or stop the engines without difficulty. The principal dimensions of the Normandy are:—Length between perpendiculars, 210ft.; breadth for tonnage, 24ft.; depth in hold, 14ft. The Normandy is the third iron vessel launched within a few months from the same yard.

TELEGRAPHIC ENGINEERING.

TRANS-ATLANTIC SUBMARINE CABLE.—A very important decision has been come to at the Telegraph Congress, at the Foreign Office, Paris. The concession of a trans-Atlantic submarine cable to M. Balestrini, sanctioned by all the Powers represented at the conference was formally ratified. The plan is to connect Europe with the Brazils, and the Brazils with North America, so that a dispatch from Paris to New York will have to go round *via* Pernambuco. The scheme is a grand one, and its boldness deserves success, but the difficulties in the way of its practical realisation seem very formidable.

TELEGRAPH BETWEEN SPAIN AND ENGLAND.—The telegraphic cable, which is to unite the coast of Spain with England, will extend from Corunna to Falmouth—a distance of 600 miles.

RAILWAYS.

CRYSTAL PALACE AND SOUTH LONDON JUNCTION RAILWAY.—A prospectus has been issued of this company, an extension of the London, Chatham, and Dover line by Peckham to the Crystal Palace. The capital is to be £675,000, in shares of £10, of which one half are to carry a 6 per cent. preference. The station at the Crystal Palace will be on a level with the floor of the building.

COPENHAGEN RAILWAY COMPANY.—A prospectus has been issued of this company, with a capital of £160,000, in shares of £10. The object is to carry out some concessions granted by the Government for the construction of lines of railway, to be worked by horses only, from the centre of the capital to the most frequented parts of the suburbs. The aggregate length of the lines to be first made is ten miles, at a cost of £4500 per mile.

THE EAST INDIAN RAILWAY COMPANY have put forth a prospectus for the construction, without a Government guarantee, of an auxiliary loop line of 120 miles between their stations at Barakur and Luckieserai. The main object is to develope a coal district, whence it has become essential for the company to obtain supplies, and at the same time to open an additional channel for the main traffic to the upper part of the Ganges, which will obviate the future necessity of doubling the existing line. As the proposed loop will run along the base of the angle formed by the present railway between Burdwan and Luckieserai it will shorten by sixty miles the distance to Luckieserai and all stations beyond it. The capital of the Auxiliary Company will be £1,200,000, in shares of £20, and the undertaking will technically be entirely distinct from the East Indian Company, although it is contemplated that the capital should be subscribed rateably by the East Indian proprietors, and that the whole system should thus be worked for one body. A good revenue is expected to be obtained from the coalfields, and certain concessions and subventions, which have hitherto been accorded to encourage companies willing to undertake railways in India without a guarantee, will be applied for, and are expected in regular course to be obtained.

ROYAL DANISH RAILWAY.—The report of the directors of this company states that the first section of the State lines, extending from Aarhuus to Randers, a distance of 40 miles, was opened by the King in September last, and the next section, of about 65 miles, will be opened next autumn. The whole length of the State lines, about 350 miles, will be completed by the summer of 1866. In route with the lines of the Islands of Fyen and Zealand to Copenhagen, the Government has recently decided that large steam ferries shall be constructed to convey trains across the channels of the Belts, and also over the Sound, in connexion with the lines of Sweden. On completion of the line north to Frederickshaven a daily steam service will communicate with Gottenburg. A working agreement for a term of twenty-eight years between the company and the Altona and Kiel Company has been provisionally entered into by the respective boards. By the provisions of this agreement, the Altona and Kiel Company binds itself to make a railway from Altona into the city of Hamburg, and there unite with the lines of Mecklenburg and Hanover. By this project a continuous line from Denmark to the Continent will be established. The Company's engineer reports that the whole of the bridges are now of a most substantial character. The capital account shows that £655,923 had been received and expended.

METROPOLITAN MAIN TRUNK UNDERGROUND RAILWAY.—A project is suggested by Mr. Charles Baylis, of the Poultry, for constructing a Main Trunk Underground Line of Railway, to commence at Stratford, to be carried down the Bow, Mile-end, and Whitechapel-roads, through the City, down Holborn, Oxford-street, and Bayswater-road, and to terminate at Shepherd's Bush. In connexion with the construction of this line of railway, it is also suggested that four lines of rails at the least should be made, and chambers should also be constructed for depositing gas and water-pipes, telegraph-wires, &c., and for any other purposes that may be considered advisable. It is concluded, that if such a railway were constructed, legislative interference would almost become unnecessary, as every other railway company would have but one object in view, namely, to arrange the best modes of bringing their traffic on the line now proposed. Would not the necessity of crossing the Thames by a north and south line of underground railway, however, make this latter line more like the criterion or key to the level of all the other lines than an east and west one?

RAILWAY ACCIDENTS.

ACCIDENT ON THE NORTH UNION RAILWAY.—On the morning of the 3rd ult. a serious accident happened on the North Union Railway, near Preston, which resulted in the destruction of a large amount of property belonging both to the company and several parties whose goods were being conveyed along the line. On the preceding night a goods train, consisting of twenty-two waggons and a guards' van, left Liverpool for the North. The journey northwards was performed quite safely and punctually until the arrival of a train at a small station called Farrington, about two miles from Preston. Near this station there is a steep gradient, falling in the direction of Preston, and when the engine had reached the base of the decline it seemed to run forward more rapidly than before, and quite beyond the rate produced by the pressure of steam upon the cylinders. This circumstance caused the engine-driver to turn round, when he observed that the whole of the train, with the exception of two waggons immediately at the rear of the engine, had been left some distance behind, the couplings having evidently been jerked loose or broken. The driver brought his engine to a stand still as soon as possible, and imagining that the waggons would follow at a slow rate down the decline, he remained stationary until they came up. It would seem, however, that they had not parted until a considerable speed had been obtained, and that their impetus gradually increased in the descent of the gradient. They ran down at a very swift space, the consequence being that the whole of the eighteen rear waggons and the van dashed into the two trucks behind the engine with great force. Twenty out of the twenty-two waggons composing the train were seriously smashed. The rails of the line were torn up and displaced for several yards, and in some places the ground was ploughed up. No one sustained any personal injury.

ACCIDENT ON THE LONDON, BRIGHTON, AND SOUTH-COAST RAILWAY.—On the 20th of May an accident, attended with considerable loss of life and severe injuries to upwards of twenty passengers, occurred on the loop line of the London, Brighton, and South-Coast Railway, near the Streatham common station. An express passenger-train left Brighton at five o'clock, conveying, in addition to the ordinar passengers two companies o

Grenadier Guards, who were returning to head-quarters from a course of rifle practice at Eastbourne. The train proceeded as usual as far as the Streatham-common station, shortly after leaving which, the engine and the entire train of 16 carriages ran off the metals for a considerable distance, and came to a stop in consequence of the boiler of the engine exploding. The shock was so great that the middle carriages of the train were doubled up, and several completely smashed.

BOILER EXPLOSIONS.

Boiler Explosion at Bilston.—On May 30th, as the day men were replacing those that had been at work during the night, one of the boilers of the old Bilston Works exploded, killing four men, and more or less injuring fifteen others. The boiler, it is presumed, exploded from beneath, as far as can be ascertained; it gave way at a seam immediately over the fire, and extended completely round the circumference of the boiler, and splitting it as clean as if it had been cut in two by a knife. The upper half turned a complete summersault, and passing between the engine-house and the stack, came to the ground bottom upwards, about five yards from the bed from which it was torn. The front half, with the exception of a few fragments, went off in an acute angle, travelled a distance of between 70 and 80 yards in the air, passing between the and over buildings, and falling immediately in front of the principal office door. Singular to state, with these exceptions, this disruption was effected without further injury than the demolition of roof and slates. There were about 200 men and boys in the works at the time.

Boiler Explosion.—On the 13th ult. a boiler exploded at the extensive works of the Dowlais Iron Company, Merthyr Tydvil, and the force of the explosion was so great that the ironwork, bricks, and other missiles were hurled in all directions. A lad, who was at work about 60 yards distant, was struck by a brick, and killed. Five others were injured, two of them seriously. The boiler, it appears, had been duly examined, as usual, and the cause of the explosion is not known.

ACCIDENTS TO MINES, MACHINERY, &c.

Colliery Explosion near Wrexham.—An explosion which caused severe injuries to seven men, one of whom has since died, recently occurred at the Brymbo Colliery, near Wrexham. It appears that a quantity of gas had collected in one of the workings, and the roof unexpectedly falling in, there was a rush of gas, which came in contact with a naked candle carried by one of the men, and an explosion ensued.

Bursting of a Tank in Portsmouth Dockyard.—In the north east portion of Portsmouth dockyard, and exactly opposite the grounds which enclose the residence of the Admiral-Superintendent, is a large iron salt-water tank, standing on lofty iron columns over some stores of oak planking. It is 160ft. long, 40ft. wide, and 5ft. deep, and is kept filled with salt water to assist in quenching any fire which might break out in its neighbourhood. On the 17th ult. an alarm was given that it had burst, and that the water which rushed out was committing great ravages upon the roadways and the Admiral-Superintendent's grounds and gardens adjoining. It was found on examination that about 70ft. of the iron plates forming one side of the tank had given way, and had been hurled with the water into the roadway. The tank was built up of cast-iron flanged plates, fastened together with bolts, nuts, screws, &c., in the usual manner. Some of the plates have been separated at the fastenings, the nuts having been torn off the screw ends of the bolts by the pressure of the water. In other instances the iron plates have been broken through diagonally, like pottery ware. The weight of the water in the tank was calculated at 890 tons, and the pressure against the side of the tank, which has given way, at about 50 tons. An inspection of the broken parts of the tank disclosed the somewhat extraordinary fact that the wrought iron tie rods in the interior of the tank were very much eaten away at their junction with the cast-iron plates, where they had been submerged in the salt water.

WATER SUPPLY.

The South Essex Waterworks.—The chalk pits of Grays, where the works are erected, and which were recently opened, are situated about a mile from the Thames; they cover an area of nearly 60 acres, and are filled with water springs, which are so prolific, and are perpetually rising in such large volumes, as to produce a million gallons per day. The Company have now completed their high service works, and have laid on the water to Brentwood and Warley; in the course of time an abundant supply of water will be furnished to the towns in the upper part of the county, and ultimately to the eastern suburbs of London. At present five pumps are employed, and the quantity of water obtained every twenty-four hours is 2,100,000 gallons. The steam-engine employed for raising the water from the chalk-pit to the reservoir at Warley, is constructed upon the principle known as Woolf's double cylinder, and is the most economical and convenient agent that can be employed for this purpose. The steam is first used at high pressure in the small cylinder, where it is allowed to exert its full power throughout the entire stroke; from this it passes into a larger cylinder four times the capacity of the small one, so that it is expanded to four times its first bulk, and, consequently, its final pressure is reduced in a like proportion; it then passes into the condenser beneath the cylinders, where it is again converted into water, and in this process a vacuum is formed which, draws down the piston on the large cylinder, and then the whole power of the steam is made available. The water is raised by a pump, which is worked by a rod direct from the wrought-iron beam of the engine. The pump is double acting, having both a bucket and plunger, and thus represents a combination of the common lift pump, with a force pump similar to that used for feeding boilers. The bucket is twice the area of the plunger, and the consequence of this is—that it draws at the up stroke the full contents of the barrel, but only discharges one-half into the delivery pipe, the other half being displaced by the plunger at the down stroke. This causes a pretty uniform flow of water, and enables it to be forced, with the assistance of a large air-vessel, straight into the main, without the intervention of a stand-pipe. It is believed that this is the only instance of water being raised to a height of 400ft. through a main 9½ miles in length. With regard to the source of the water, it issues from the chalk formation out of vertical fissures which have been formed by some upheaving of the strata, and which takes one general direction. To obtain water, all that is to be done is to cut across these fissures, each of which is separate from the other. Owing to the operations which have taken place in working these chalk pits, very little tunnelling is required. The tunnel in use at present is 25ft. and 5ft. broad, and this can be extended to indefinite proportions according to requirement.

Waterworks at Hay, near Hereford.—The waterworks of this town are now completed. The reservoir, 175ft. by 54ft., and 11ft. in depth, is supplied by a mountain stream some half a mile distant, which is diverted, and then passed through a filter, 6ft. in depth, of gravel and sand, before entering the reservoir, where it is joined by two springs obtained by boring about 30ft. to rock (old red sandstone formation). Previously to these supplies entering the mains from reservoirs, they have to pass through another filter bed, on the ascension principle, formed of slabs, with a pressure of 12ft. The supply is thus filtered by descent and ascent.

The Water Supply of Paris.—The aggregate of the present water supply of Paris is 5,400,000 cubic feet, 3,700,000 of which are derived from the Ourcq canal. The total length of the water-pipes for the private supply is 68,729ft.; for the public supply, it is 2,476,621ft.; the largest diameter of the pipes is 3ft. 7·3in. Two new pumping engines of 100 horse power are now being erected on the Quai d'Austerlitz; they will add from 400,000 to 500,000 cubic feet to the water supply of the suburban districts.

GAS SUPPLY.

Gas Works in Germany.—There are in Germany 266 gas works, of which 66 are worked by townships or individuals, and 200 belong to various companies. The combustible employed is chiefly coal, the largest quantity being supplied from England. Out of 7½ million quintals, 3,350,000 are obtained from the English collieries. Berlin, which produces annually 800 million cubic feet of gas, uses about half of this quantity of coal. Hamburg takes more than 500,000 quintals, and the rest is used in the gas works of Altona, Lubeck, Rostock, Stralsund, Stettin, Dantzic, Konigsberg, &c. The excellent quality of the English coal for gas-making causes the preference to be given to it over indigenous coal; but if the cost of transport of the latter can be cheapened, it is thought that it will ere long come into use in Hamburg, Berlin, and other towns. The following are the per centage proportions in which the various coal is used in Germany:—

English coal	46·00
Westphalia	18·00
Moravia	11·50
Zwickan	7·50
Saarbuck	7·00
Silesia	5·00
Dresden	2·25
Bohemia	2·00
Northern Bavaria	0·75
	100·00

Besides the gas works which consume coal, Germany possesses 20 in which wood alone is employed for distillation; and there are two small works in Holstein, which consume peat or turf at certain times, and at others coal. The retorts used are generally of clay, except in those works where gas is made from wood. The total number of retorts employed is estimated at 7337, made for the most part in the immediate locality of the works; their form and size differs considerably. Assuming that the mean consumption of gas in the 24 hours is 25 millions of cubic feet, and supposing that each retort furnishes daily 4500 cubic feet, it follows that these 7337 retorts must be continually, or three-fourths of the time, in work. The use of extractors is much less general than would be supposed. There are only 90, or less than a third of the whole of the gas works in Germany which employ about 107 extractors. The small works do not employ them at all. The meters in general use are water meters of native manufacture, and may number about 139,000. The mean number of lights of each is about eight.

Photogenic Gas.—A prospectus has been issued of the Photogenic Gas Company for the purpose of introducing the patent of M. Mongruel, which is alleged to produce either from ordinary gas or from atmospheric air, a light more powerful, cheap, and healthy than any hitherto known. The proposed capital is £200,000 (of which one-half is to be first put forth) in shares of £50. The price to be paid for the patent is £5000 in cash and £45,000 in shares.

Mauritius Gas Company.—The prospectus is issued of this Company with a capital of £100,000, and a first issue of £60,000, in 12,000 shares of £5 each. This company is established to supply gas in the British possession of Mauritius, and it intends to commence operations forthwith in Port Louis, all classes in the community being desirous to adopt the European system of lighting. The company's agent at Port Louis has chosen an eligible site for the works, close to the harbour's edge, where coal and other materials can be landed, and it is stated that the profits will give a *minimum* return of 12 to 15 per cent. on the capital to be invested.

DOCKS, HARBOURS, BRIDGES, &c.

Blackpool Pier.—This pier was designed by and erected under the supervision of Mr. Eugenius Birch, C.E., London, and is constructed almost entirely of iron, the only woodwork employed being that used for the deck and the fender piles at the head. The following are the dimensions of the pier:—Approach, 80 feet long; abutment, 120 feet long and 45 feet wide; main portion, 1070 feet long and 28 feet wide; and the head, 135 feet long and 55 feet wide, giving a total length of 1405 feet available as a promenade. The entire superstructure rests upon clusters of iron piles, vertically fixed into the ground by means of screws. The piles at the abutment and main body are wholly of cast iron, and those at the head are partly of cast and partly of wrought iron. The largest of the cast-iron columns are 12 ins. in diameter, and of an average thickness of 1⅛th in. and the whole of the columns are filled with concrete, which imparts to them additional stability as a means of support. The piles are placed in clusters, as this mode of arrangement has been found by the engineer to answer in exposed positions; for, the piles being trussed together, and well secured longitudinally, transversely, and diagonally, by the rods and braces, are capable of sustaining sudden shocks of the sea, a most important consideration at this point of the coast, where there occurs an extraordinary rise of tide of 35 feet. The clusters are placed at intervals of 60 feet; and resting upon them are the main girders, constructed of wrought iron, and in lengths of 72 feet. The description of girder employed is the plate girder. Throughout the entire length of the pier an ornamental casting surmounts the main girder; and this forms a very good back for the sitting accommodation afforded by these girders. The head of the pier stands 50 feet above low-water line, and every means have been used to give it strength and stability. The total weight of iron employed upon the pier is 760 tons, consisting of 420 tons cast, and 340 tons wrought. The first column of this pier was fixed in May last year.

The Clifton Suspension Bridge at Bristol.—The coils of the temporary bridge necessary for the construction of this work have been passed across the Avon. A thin rope was lowered from the Clifton buttress, and the end conveyed across the river in a boat to the Leigh side, and then attached to a thick hawser, which was hauled across and secured. The first of the wire coils, 1100ft. in length, and weighing 2 tons, was then successfully suspended across the chasm at St. Vincent's rocks. Nine coils of this kind have been suspended, a strong cradle will be attached to two of them and swung down to the centre of the chasm, and in this the workmen will commence bolting the planks for the platform, gradually completing this stage as they near the inclines, the declination of which is about 1 in 2½. The platform completed, a "traveller" will be attached to one of the wire cables, and the chains, &c., will be conveyed to any part of the platform, above which the suspension bridge will be erected.

MINES, METALLURGY, &c.

Northumberland Coal Measures.—A report has been made to the River Tyne Improvement Commissioners by Mr. T. E. Foster and Mr. John Taylor, relative to the existing state and prospects of the Northumberland Steam Coal-field and the quantities that may be expected to be shipped therefrom, upon the Tyne. They report that they have measured the respective royalties in which is being wrought at the present time the Low Main, or best steam coal of the district; and after making full allowance for the quantity already excavated, loss by dikes, small coals left under ground, and screened out on the surface, they find that there is sufficient to endure, in the present rate of shipment of steam coal on the Tyne, in addition to the portion diverted to Sunderland Dock, for a period of 110 years. But the present collieries could produce from 20 to 25 per cent. more than they do at present, were the demand to arise. On this head there would be an increase of, say 300,000 tons; a new colliery is being opened out at

Camboise, from which may be computed an annual vend of 160,000 tons, and from Sleekburn 80,000 tons; and other districts adjoining, 160,000 tons—total, 700,000 tons. The increase of the steam coal trade from the Tyne has been as follows:—1859, 1,275,707 tons; 1860, 1,647,091 tons; 1861, 1,544,067 tons; 1862, 1,955,586 tons. Besides the Low Main seam, there is another coal called the Yard seam, which is capable of being worked in very large pieces, and combines in a great degree many of the excellencies peculiar to the Low Main seam. This seam is almost entire throughout the district, and there is sufficient left to endure, on the existing vend, for a period of 60 years. In addition to the Low Main and the Yard coal seams the following are met with, more or less, in the district on the north and south sides of the Tyne:—The Stone coal seam, Bersham seam, six quarter seam, five-quarter seam, the Townley seam, and Walbottle seam; and to the north, some distance from the large downcast dike of 90 fathoms, the High Main seam, stone coal seam, Bersham seam, gray seam, Plessy coal seam, and Beaumont seams. These seams are not now in operation, because, at the respective collieries, the Low Main and Yard seams are worked, as being more productive of profit. But there can be no doubt, as these are all workable seams, the time will arrive, as demand arises and coal becomes further enhanced in value, that they will come into operation. As regards the inferior description of coal, the time (110 years) is so distant when the steam coal of the first quality will be exhausted, and as in addition the Yard seam will endure 60 years, together 170 years, Messrs. Foster and Taylor did not think it necessary to go into the question of the quantity of inferior coal in reserve, excepting, generally, to remark that the various inferior seams of coal will naturally come into operation as those of superior quality are exhausted.

Another New Metal.—A letter from France says that another new metal has been announced there. M. Osravais, Professor of Geology at Strasbourg, has obtained a hard shining metal, of the colour of gold, but soft as lead, from the mineral waters of Alsace. The metal, not admitting of a high degree of polish, will be useful to employ in the dull or coloured goldsmiths' work so much in fashion for ornament just now. The specimens, submitted to connoisseurs in Paris, have excited the highest admiration.

Extracting Gold from Quartz.—A new method of depriving gold ores of sulphur has been introduced in America. It consists in reducing the ores to fine dust, then forcing the dust by a draft through a flame of pine wood. The furnace used is a square brick structure, with a grate about 3ft. wide by 4ft. in length, and 3ft. high, in which a fire of common pine wood is built. The flame from this fire-place escapes into a chimney built in the shape of a muffle, and instead of rising upwards, runs down towards the lower floors at an angle of 45 degrees. The tube containing the ground quartz enters this muffle-shaped chimney at its upper end, just where the blaze from the furnace enters, and the strong current carries the flame its whole length. There are several round holes an inch or two in diameter, at intervals of about 3ft. along both sides of the chimney. Through these, when the apparatus is in operation, a further supply of air than that furnished by the blower is sucked in and assists in decomposing the sulphur contained in the ore. In passing down the flue, or chimney, the pulverised ore is blown through a jet of flame, as dust, from a distance of about 20ft., the length of the flue, and each particle being separate, is surrounded by air and a strong flame, and it becomes red hot, giving off its sulphur, arsenic and other volatile constituents. After passing down the flue, it falls into a receptacle of brickwork, whence it is raked out upon an earthenware floor to cool. The ore now presents about the same appearance as that burned in a reverberatory furnace. The amalgamation machinery is simply an arrastra about 8ft. in diameter, with a stone bottom and dragstone. By this process three times more gold, it is stated, are obtained by it than by any of the old processes. Sulphur, arsenic, and iron quartz prevent, in a great measure, the mercury from amalgamation with the gold.

Platinum.—At the Paris Academy of Sciences, a communication was received from Messrs. Sainte-Claire Deville and Troost, showing that platinum, though apparently a most compact metal, will admit of the passage of certain gases through its pores at a high temperature. To ascertain this, the authors of the paper had caused a platinum tube to be drawn all of one piece, so as to be free from all solder, and to present an uniform and unbroken surface. This platinum tube was introduced into a porcelain one, so that an empty cylindrical space was left all round between the two, properly stopped at each end. Through this space a constant current of hydrogen was made to pass by means of two glass tubes inserted at the extremities, so as not to allow of the slightest communication with the platinum tube which was filled with dry air. On exposing this tube to a high temperature, the air by degrees lost its oxygen, and water was formed; a circumstance which could only be explained by admitting that hydrogen had penetrated through the pores of the platinum tube; and, on the temperature being further raised, a considerable quantity of free hydrogen was found to issue from that tube. This shows that platinum, at a high temperature, is capable of producing the phenomenon of endosmosis with gases.

APPLIED CHEMISTRY.

Use of Sulphurous Acid in the Manufacture of Sugar.—M. A. Reynoso points out the use of calcium bisulphite as prejudicial rather than advantageous. The excess of acid uniting with oxygen produces sulphuric acid, which reacts upon the sugar, converting it into grape sugar, and eventually into ulmic and formic acids, and ulmin, thus tending to produce colour, instead of bleaching the saccharine liquid. Hence, he states that when the sulphite is used it should always be with an excess of lime. It is indispensable that the cane-juice should be so alkaline as to turn litmus-paper blue. In the absence of litmus-paper, the alkalinity of the cane-juice may be ascertained by its turbidity, and by the formation of a pellicle on the surface of a small portion when it is breathed upon.

Note on Experiments with Nitrates, by Mr. J. Horsley, F.C.S.—If a small portion of pyrogallic acid from the point of a penknife be projected into a vessel containing about two or three drachms of water, it will, in the course of twenty-four hours, or less, assume a dark brown colour, from the absorption of oxygen from the air, but not so if the pyrogallic acid be dissolved in water acidulated with a few drops of sulphuric acid. It therefore occurred to me as an useful means of detecting nitrates and nitrites, as the following experiments prove:—If into a test-glass containing two or three drachms of water, acidulated with a few drops of sulphuric acid, a small portion of pyrogallic acid be projected, and then a little strong sulphuric acid be carefully trickled down the sides to about one-fourth from the bottom, little change will ensue beyond a faint violet coloured line at the point of contact of the two fluids. A grain of chloride of sodium being added, a brisk effervescence runs throughout the sulphuric acid from the evolution of chlorine, which somewhat increases the violet colour, but on projecting the merest particle of a solid nitrate (say nitrate of potash) it will, on falling, carry with it so much of the pyrogallic acid as to be reacted on by the nitre and produce an intense purple colour, which, gradually mixing with the upper layer of the pyrogallic acid solution, gives off streaks or rings of orange-yellow, by becoming oxydised at the expense of the decomposed nitric acid of the nitrate. On the other hand, if the nitrate be first mixed with two or three times its bulk of chloride of sodium, and then projected through the pyrogallic acid liquor to the sulphuric acid below, no purple colour is produced, but the resulting effervescence causes the evolved nitrous acid to act more uniformly on the whole of the pyrogallic acid, imparting a deep orange brown colour. Such is the sensibility of this reaction, that even a drop or so of a solution of a nitrate added to the pyrogallic liquor previous to the projection of the chloride of sodium suffices to show the discolouration caused by the liberated nitrous acid, the intervention of the chloride of sodium, from the smallness of the nitrate, being necessary to its production, and renders it more evident than when the nitrate is used alone. Only part, however, of the drop of nitrate solution which comes into contact with the sulphuric acid will be decomposed, and even that is sufficient to give an intense colour. The nitrous acid evolved from nitrates by heat or otherwise, is also detected in its dry state by the discolouration of a piece of white paper moistened with a tolerably strong pyrogallic acid solution. In fine, I am of opinion that this method of testing for nitrates and nitrites is far more delicate than any at present in use. Simple, easy of execution, and perfectly unobjectionable. It is desirable that a piece of white paper should be placed at the back of the test-glasses, in order to show the reaction best, and also that no more chloride of sodium be used than is necessary, or equal to the sulphuric acid, so as not to lay undecomposed at the bottom of the glass. Preference would appear to be given to the use of the dry salt with the chloride of sodium rather than a liquid nitrate.

Action of Sulphur on Saline Solutions having an Alkaline Reaction.—M. J. De Girard has observed that by boiling a solution of soda pyrophosphate with an excess of well-washed flour of sulphur, the liquid rapidly becomes brown in consequence of the formation of polysulphide. By continuing the ebullition for several hours, hydrosulphuric acid is abundantly evolved. The liquid gradually becomes colourless, meanwhile disengaging hydrosulphuric acid. The filtered liquid contained soda hydrosulphite and a salt of phosphoric acid. Silver nitrate solution was added as long as the white precipitate, first formed, was rendered black by the formation of sulphide, and after separating this precipitate the filtrate gave a yellow precipitate with the silver solution. A solution of sodium sulphide boiled with excess of sulphur evolves hydrosulphuric acid, and when the liquid has becomes quite colourless and neutral to test-paper, it contains only soda hyrosulphite. Under the same circumstances, sodium sulphide alone, decomposes water at 100° C., evolving hydrosulphuric acid. Water boiled with washed sulphur is also decomposed with evolution of hydrosulphuric acid.

New Mode of Producing the Anhydrides of Monobasic Acids.—M. H. Gal has obtained acetic and benzoic anhydrides by the reaction of the corresponding chlorides with anhydrous baryta. It is necessary to avoid using an excess of baryta. Anhydrous lime and oxide of lead produce the same result; the latter at a temperature of 150°; the former with such violence as to become incandescent. The reaction with acetyl chloride commences at the ordinary temperature, and is completed after the mixture has been kept for a few hours at 100° C. In the case of benzoyl chloride, a temperature of 140° to 150 C. is required.

On the Electro-Chemical Decomposition of Insoluble Substances, by M. Becquerel.—Whilst seeking to oxidise silicium at the positive pole, in distilled water, with a pile of eighty elements of sulphate of copper, I found that this metalloid is not, as has hitherto been supposed, a non-conductor, but that it possesses, when traversed by an electric current, sufficient conductility to produce remarkable caloric effects, by reason of its great resisting powers. By putting small cylindroid crystals of silicium, prepared by M. Deville's process, into a porcelain, or better still, a platinum capsule, in communication with one of the poles of the pile, and closing the circuit with a platinum-wire, at least one millimetre in diameter, then by simply touching with this wire one only of the crystals, the adjacent crystals become incandescent. All the crystals follow the wire when it is raised, forming a small chain with reddish white heat; at the same time a white smoke arises, more or less visible, according to the force of the pile, and possessing an odour rather like that produced by breaking a piece of flint. The intense heat is really produced by the resistance offered to the electricity when traversing the silicium; for this result is obtained by using a pile of such force, that by touching the platinum capsule with a wire of the same metal only a feeble spark is emitted. In experimenting with a nitric acid pile of twenty elements the heat is so intense that the platinum vessel is perforated, being melted where it becomes in contact with the substance, as well as the end of the platinum wire, and, at the same time, a white smoke is disengaged, with formation of silica, deposited as powder on the melted platinum, and also some silicide of this metal. With charcoal electrodes complex effects are obtained, resulting from their combustion and the effects above described. The light is then too brilliant to be borne by the naked eye. In this and the preceeding instance it is necessary to operate on a plate of rock crystal, the surface covered with silica; under the microscope this silica appears to be in a vitreous condition.

New Methods for Testing the Purity of Alcohols and Ethers by M. Berthelot.—Though alcohols and ethers have been carefully purified by distillation and desiccation, there has hitherto been in most cases no means of controlling their purity. The following are the results of my researches:—1. I take as a starting point the fact that a compound ether, if pure, is decomposable by an alkali, by saturating an equivalent weight of this alkali. By this means, as I showed about ten years ago, the analysis of ethers and analagous compounds, is founded on an alcalimetric test, based on the use of a standard solution of baryta. 2. By means of the same liquid the smallest quantities of compound ethers may be recognised and estimated in alcohol or in simple ethers, provided these bodies are not alterable by alkalies. Ten cubic centimetres of a standard solution of baryta, and a known weight of the body to be tested, are enclosed in a flask. It is then heated for about a hundred hours at 100°; if the alcohol is pure, as is oftenest the case with ordinary alcohol, the standard of the baryta does not change. Amylic alcohol, on the contrary, almost always contains a small quantity of compound ethers, as also does ordinary ether, even after digestion on milk of lime. Glycol prepared by the ordinary methods, and rectified to a certain point, is particularly impure. I have found in it as much as 22 per cent. of combined acetic acid, corresponding to 40 per cent. of monoacetic glycol. This fact may occasion more than one error, and the knowledge of it will be useful to chemists occupied with this curious substance. To recognise the presence, without estimating, of a neutral ether in an alcohol, I heat the alcohol with twice its volume of water, for twenty hours at 150°. Most of the neutral ether changes into acid. 3. The presence of a free acid in an alcohol or an ether is so easily recognised that I need not stay to describe the process. Formic ethers, for instance are always acid; but they decompose so promptly as to prevent the exact estimation of the free acid. The free acid of other ethers, on the contrary, can be precisely estimated. 4. The presence of a small quantity of water in a neutral ether may be detected by heating this ether to 150° during twenty or thirty hours; the water decomposes an almost equivalent quantity of ether into acid and alcohol. The acid is then estimated by a standard solution of baryta. On submitting acetic ether, carefully purified by the ordinary methods to this test, it will obstinately retain a centieme of water, which is with great difficulty eliminated. 5. The presence of a small quantity of water in alcohol may also be detected by mixing the alcohol with a perfectly anhydrous compound ether, tested as above. It is then heated for twenty or thirty hours at about 150°. If the alcohol is anhydrous the mixture should not become acid. 6. The presence of a small quantity of alcohol in a neutral and anhydrous ether, acetic ether for instance, may be detected by heating the ether with a known weight of pure acetic acid. The standard of the acid will diminish according to the amount of alcohol.

Manufacture of Oxide of Zinc.—An invention has been patented by Mr. George Darlington, of Minera, which consists in mixing zinc ores, with or without flux, with any description of smokeless carbonaceous material, for the purpose of reducing such ores, especially with anthracite coal. He exposes the said mixture to the action of heat resulting from the combustion of a further quantity of this smokeless fuel, by placing it in a blast-furnace, or in any furnace where a bar or perforated plate grate, the ash-pit to which is closed, and which form the air-chamber for the reception of air furnished for the combustion of the contents of his furnace, either by fan or otherwise. The furnace is an open furnace. There is a collecting apparatus above the furnace, and into this the gases are turned as soon as the green tint indicating the formation of zinc oxide shews itself.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent, Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated May 26th, 1863.

1321 A. Haley—Jacquard looms.
1322 J. Munro & R. Scott—Boring, mining, and excavating, or cutting, motive power engines, and pressure gauges.
1323 E. K. Dutton—Cleansing seed cotton.
1324 M. Henry—Raising, forcing, and moving fluids.
1325 J. Buckingham—Ploughs.
1326 F. W. & J. Kitson—Tyres for railway wheels, and securing the same to the wheels.
1327 W. E. Newton—Separating the fibre from the flesh of plants.

Dated May 27th, 1863.

1328 A. P. Hernandez & P. B. Crespy—Soap of rice.
1329 W. Clark—Offensive and defensive arms.
1330 A. Bastow—Looms for weaving.
1331 H. C. Coulthard—Blast engines.
1332 H. J Kennard—Wrought-iron cylinders.
1333 C. Gammon—Spring fastening.
1334 W. Palliser—Projectiles for ordnance.

Dated May 28th, 1863.

1335 F R. Pilatz—Producing ornamental surfaces for decoration.
1336 W. I. Ellis—Steam boilers.
1337 C. T. Boutel—Instrument for measuring distances and altitudes
1338 G. Gore—Gas burners and furnaces.
1339 C. E. Laederich—Watches.
1340 H. Cartwright—Steering vessels.
1341 C. F. Baxter—Hollow elastic stopper for bottles and jugs.
1342 T. Richardson & R. Irvine—Treating the waste liquor obtained in the preparation of esparto grass.
1343 F. Oshourn—Pressing, smoothing, and finishing garments.
1344 H. T. White—Hats, caps, and other coverings for the head.
1345 T. Jarvis—Obtaining vegetable extracts.
1346 R. A. Brooman—Paddle wheels.
1347 W. Needham & J Kite—Expressing liquid and moisture from substances, and separating the liquid from the solid portions thereof.

Dated May 29th, 1863.

1348 E Ironmonger—Loose clip and socket joint.
1349 A. Ahadie—Railway breaks.
1350 W. Loeder—Rails for railways.
1351 J. J. Potel—Accelerating the draft in fornaces and fire-places.
1352 G. H Pierce—Heating buildings by means of hot water.
1353 R. Barker—Matches.
1354 W. Green—Producing black colouring matters or pigments.
1355 J. H. Johnson—Lubricating material.
1356 F. Patureau—Card board or paper boxes or receptacles.

Dated May 30th, 1863.

1357 E. T. Hughes—Transmission of motive power.
1358 E. P. Mosman — Obtaining and applying motive power.
1359 J. Heard—Distributing manure.
1360 V. Baker—Ordnance.
1361 S. Bates & J. Jardine—Carriages used in machines employed in the manufacture of lace or other fabrics.
1362 W. Clark—Manure.

Dated June 1st, 1863.

1363 J. Henson—Railway carriages.
1364 J. Chalmers—Armour for forts and floating batteries.
1365 W. Clark—Printing fabrics, papers, and other surfaces in colours.
1366 F. W. Smith—Conveying goods from a warehouse or vessel by pressure of air or by vacuum and atmospheric pressure.
1367 L. S. Chichester—Drying grain.
1368 J. Davey—Horse rakes.
1369 A. V. Newton—Marline spike.
1370 C. Belcher—Cutting and transplanting turf.
1371 H. C. Coulthard—Packing for the glands of piston rods and other moving mechanism.

Dated June 2nd, 1863.

1372 J. Mellard — Double moulding or ridging ploughs.
1373 A. Illingworth—Boots and shoes.
1374 J. H Brierley—Application of leather in the manufacture of gentlemen's scarfs and ties.
1375 G. H Cottam—Saddle bracket and bricks for paving stables.
1376 D. Wilson & E. A. Cowper—Presses.
1377 G. A. Barrett, W. Exhall, C. J. Andrews, & A. Burrett—Valves for regulating the speed of steam engines.
1378 T. Page—Shoeing horses.
1379 E. J. Jarry—Clearing and ploughing land by steam or other power.
1380 E. H. Letang—Ruling and printing machine to be used either combined or separately.
1381 R. Crawford—Jacquard machines for weaving ornamental fabrics.
1382 T. Agnew—Coating moulded or other surfaces with composition.
1383 W. Gleave & T. Young—Supplying water to steam boilers.

Dated June 3rd, 1863.

1384 J. Travis—Preventing incrustation in steam boilers, steam generators, and fuel economisers.
1385 E. A. Locke—Securing identifying labels or tags to bales of fibrous material.
1386 T. Claridge—Spur wheels used in the construction of mill and forge gearing.
1387 G Davies—Ginning cotton.
1388 W Lee & J. G. Winter—Steam fire-engines.
1389 F. S. Barff — Protecting, preserving, and hardening surfaces of brick, cement, stone, and stucco.
1390 J. J. McComb—Presses for forming bales of cotton and other materials, and fastenings for and means for applying bands to such bales.
1391 J. Portlock—Alarum apparatus.
1392 J. Maurice—Instruments for ruling.

Dated June 4th, 1863.

1393 S. Blake, T. Lee, & R. Dutton—Flour and meal mills.
1394 H. Rigby—Steam boilers and furnaces for the consumption of smoke.
1395 M. V. L. de Wailly—Preservation of carpets from the effects of dust.
1396 H. Pollack—Scarlet colour.
1397 W. E. Newton—Casks, barrels, kegs, and other analogous articles.

Dated June 5th, 1863.

1398 S. S. B. Guillaume—Bricks.
1399 F. A. Calvert—Steam engines, steam boilers, and steam heating apparatus.
1400 R. W. Sievier—Jacquard machines.
1401 A. Q. de Gromard—Musical instruments
1402 R. A Brooman—Treating liquorice root to obtain liquid and solid extracts therefrom.
1403 T. Gray—Flax, hemp, and other vegetable fibrous substances in order to bleach and separate the fibres
1404 J. Seaman—Implements for the cultivation of the soil.
1405 W. Clark — Distillation and separation of hydrocarburets and their derivatives.
1406 J. H Johnson—Smoothing irons.

Dated June 8th, 1863.

1407 W. A Brown—Indicator for railway trains.
1408 R. Wallis—Loading and unloading vessels, and elevating and otherwise conveying sacks, casks, and other packages and parcels from one locality to another.
1409 A. J. Hollingsworth — Spirit compass with screw lever.
1410 C. E. Newcomen—Treatment of peat and other substances containing moisture.
1411 J. Hogg—Show cards.
1412 N. Walton—Drying and airing clothes.
1413 W. C. Brocklehurst, J Creighton, C. Makinson, & J. Creighton—Winding yarns or threads.
1414 W. Miller—Ships, vessels, and boats.
1415 W. Clark—Mounting and fitting bedsteads, chairs, and other moveable seats on board ship
1416 W. Clark—Device for turning cross head wrists or pins, or for turning any cylindrical part of machinery which is secured between two arms.
1417 E. A. Schofield—Paring, rasping, and scraping the edges of boot and shoe soles and heels.
1418 G. W. E. Friederich—Ink.
1419 W. E. Gedge—Kites.
1420 J. G. Jones & R. Ridley—Working coal and other mines.
1421 E. Humphrys—Surface condensers.
1422 R. C. Furley—Castor and other oils for medicinal use.
1423 H. Reynell—Substitute for ordinary felt and kamptulicon.
1424 W. E. Newton—Needles.
1425 W. E. Newton—Nozzles for hose and water discharge pipes.
1426 J. Petrie—Washing wool and other fibrous materials.
1427 T. Page—Propelling vessels.

Dated June 9th, 1863.

1428 G. Hills — Obtaining certain products from hops.
1429 B. Dobson & D. Greenhalgh—Preparing cotton and other fibrous substances.
1430 E. Barlow, J. Newhouse, F. Hamilton, & W. Hope—Grinding card teeth.
1431 C. Nicquet—Sorting and washing ores.
1432 J. Edwards—Railway chairs and sleepers
1433 R. A. Brooman—Distillation of bituminous substances.
1434 J. Murray—Holders for inserting and fixing photographic pictures in albums.
1435 H. Martin—Treating and preparing night soil and sewage with other materials as a manure.
1436 M. Siegrist—Fountains.
1437 W. E. Newton—Propulsion of ships and other vessels.
1438 H. F. McKillop—Compositions for coating ships' bottoms.
1439 H. Bessemer—Hydrostatic presses and hydraulic apparatus.

Dated June 10th, 1863.

1440 W. Madders—Ornamental fabric.
1441 R. Aitken—Permanent way of railways.
1442 W. Roberts—Steam boilers.
1443 T. Adams—Slide and other valves.
1444 J. Brooke—Miners' lamps.
1445 W. Wells & J. W. Myers—Obtaining artificial light from volatile liquids or fluids.
1446 T. Evans & E. Hughes—Applying one or more colours of ink to type in letter-press printing by hand.
1447 W. Clark—Locomotive apparatus.

Dated June 11th, 1863.

1448 M Hatschek—Mashing.
1449 W. Clark—Obtaining and applying motive power.
1450 T. M. Harrison—Metallic casks.
1451 M. Henry—Treating floss silk and silk waste.
1452 J F Kain—Umbrellas, parasols, sunshades, walking sticks and whips, and brooches and other ornaments.
1453 E. Deane—Cooking and culinary utensils.
1454 C. L. V. Tenac—Railway wooden sleepers.
1455 C. L. V. Tenac—Daily balance hook with moveable tickets or slips.
1456 J. Webster—Indurating iron, and protecting iron and steel from oxidation.
1457 W. Walton—Pneumatic hammer.
1458 J. A. Schlumberger—Preparation of aniline dyes or colouring matters for dyeing, staining, or printing textile substances.
1459 W. Seed—Drawing, slubbing, roving, and spinning cotton and other fibrous material.
1460 E. O. Hallett—Sides of ships, batteries, and fortifications, and applying armour plates thereto.
1461 J. Johnson—Lubricating apparatus for the cylinders of steam engines.
1462 J. Johnson & W. Braithwaite—Reversing levers for locomotive engines and others
1463 T. A. Elliott—Reefing topsails and courses.

Dated June 12th, 1863.

1464 W. Sims—Compound extract for the cure of deafness.
1465 F. A. & F. Calvert—Burring, ginning, cleaning, and carding cotton.
1466 G. Davies—Currying and cleaning leather.
1467 J. Place—Materials for the purposes of sizeing and stiffening.
1468 J. C. Wilson—Reducing cocoa nut kernels and other substances to a state of pulp.
1469 J. C. Wilson—Unhusking rice and other seeds.
1470 G. Bedson—Cupolas and blast furnaces
1471 T. C. March—Ornamentation of articles of furniture
1472 T. H. Milner—Thrashing machines.
1473 R. Hughes—Scraping and sweeping turnpike and other highways, carriage drives, and footwalks
1474 H S. Barron—Steam fire engines.
1475 J. F. Tone—Prevention of smoke in steam and other furnaces.
1476 G. Davidson—Paper bags.
1477 J. Jones—Gas regulators.

Dated June 13th, 1863.

1478 G. Davies—Oiling journals or axles.
1479 T. Wrigley—Filtering or cleansing water or other fluids.
1480 J. Hopkinson—Fastening the ends of metal bands.
1481 W. N. Hutchinson—Cleansing ships' bottoms and sides.
1482 R. Blackburn—Traction engines.
1483 T. A. Elliott—Ballasting ships and other vessels.
1484 A. Mehu—Helm for working the rudders of ships or vessels.
1485 J. S. Benson & D. Jones—Removable head for casks.
1486 M. B. Westhead—Adapting tapes, ribbons, and other such narrow fabrics or thread to surfaces from which they may be unwound, or upon which they may be rewound.
1487 I. G & W. Bass—Nails and spikes.
1488 H. G. W. Wagstaff—Feeding steam boilers with water.
1489 S. S. Robson—Working the rudders of vessels and auxiliary steering apparatus.
1490 J. Shand—Steam fire engines and boilers.

Dated June 15th, 1863.

1491 W. W. Box—Fire bars for the boilers of locomotive and other engines, and fire boxes and furnaces generally.
1492 J. Forrester—Bricks, quarries, slabs, tiles, eartheuware pipes, and other eartheuware or ceramic articles.
1493 T. Cope—Rocking horses.
1494 H. B. Barlow—Opening and cleaning cotton and other fibrous substances.
1495 I. B. Harris—Flexible and other tubes.
1496 J. Juckes, jun.—Furnaces.
1497 C. Petitjean—Glass.
1498 R. W. Gordon — Spinning flax and other fibrous substances.
1499 W. Clark—Engine for obtaining motive power from steam or other liquid.
1500 P. P. L Stafford—Fire-arms.

Dated June 16th, 1863.

1501 J. J. Sheillock—Valves for the passage of steam, gas, and fluids.
1502 F. S. Williams—Shaping plastic materials and hot but not melted metals by means of pressure, percussion, or rolling.
1503 W. Manwaring—Harvesting machines.
1504 R. Grogan — Graveling and macadamizing roads and paths.
1505 J Lightfoot—Fixing mordants in the processes of dyeing and printing textile fabrics and yarns.
1506 J. G. Jennings & M. L J. Lavater—Moulding and vulcanizing articles of india rubber.
1507 W. Score—Candles and soap.
1508 J. Steele & W. Mason—Removing the bran or outer skin from wheat or other grain.
1509 A. J. Fraser—Apparatus applied to house and carriage window sashes for the working and fastening thereof.
1510 W. Neill, jun.—Steam engines.
1511 J. C. Onions—Smiths' and other bellows.
1512 R. A. Brooman—Preserving the silvering or quicking on glass, and glass vessels for silvering or quicking.

Dated June 17th, 1863.

1513 W. H. Dawes—Iron.
1514 J. Bonwell—Collecting and placing in rows, or collecting and elevating into a waggon or elsewhere hay, corn, or other agricultural produce.
1515 J. Mills—Square rigging of vessels.
1516 J. Newnam—Boiling in vacuo at a low temperature.
1517 J. F. Spencer—Steam, gas, and water tube joints.
1518 W. Crofts—Production of fabrics by lace machinery.
1519 F. de Wylde—Preservation of lead surfaces exposed to the action of water, and for the protection of such surfaces from decomposition by atmospheric action.
1520 E. Wolf—Article or means for use in smoking tobacco.
1521 T. Purdie—Plastering, colouring, and decoration of walls and ceilings.
1522 A. Samuelson—Evaporating liquids.
1523 W Naylor—Compressing, holding, and regulating the pressure of gas.

Dated June 18th, 1863.

1524 J. A. Sparling—Twisting and winding silk.
1525 J. L. Gnnne—Toy pistols.
1526 W. S. Lowe & J. Cheetham—Self-acting mules for spinning cotton and other fibrous materials.
1527 D. Barker—Treatment and preservation of yeast.
1528 J. Ralph & A. Heald—Sewing machines.
1529 E. Ivett—Tiles.
1530 R. Jobson—Moulds for casting metal.
1531 E. Gossiava—Bolts, rivets, and spikes.

Dated June 19th, 1863.

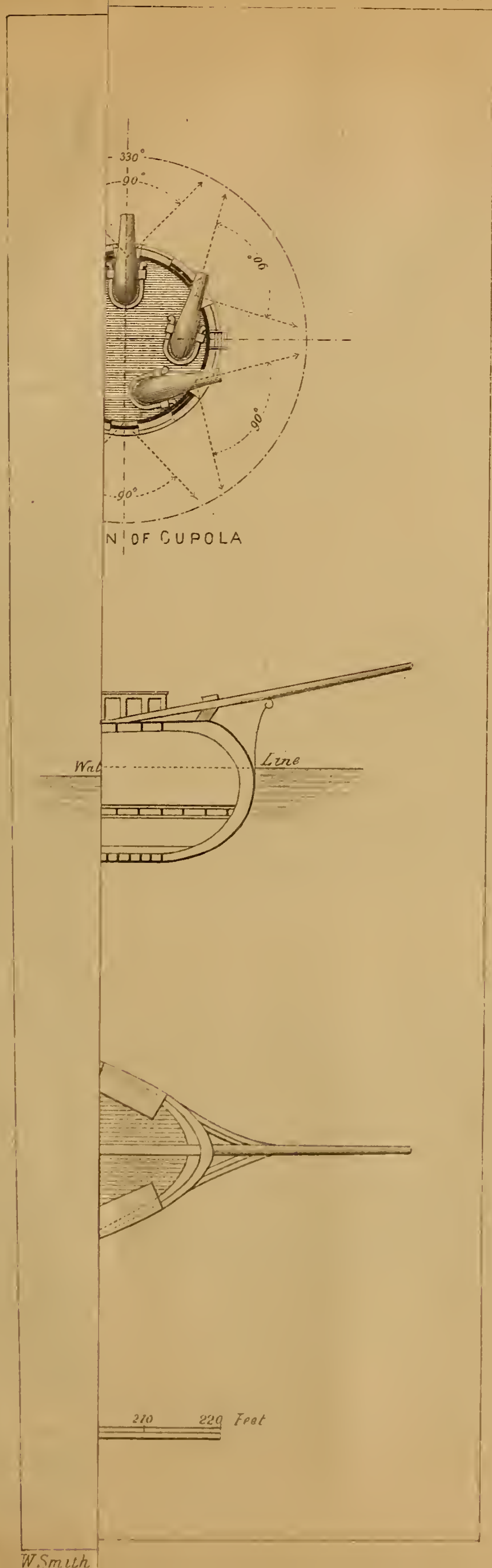
1532 H. Reynolds—Rendering atmospheric air fit for illuminating purposes, and of increasing the illuminating power of inflammable gas.
1533 E. Howarth and J. Brown—Steaming cotton or other fibrous substances.
1534 S. Middleton—Iron or other metal shoes, and the securing the same to the hoofs of horses and other animals without nails.
1535 R. Marrison—Breech-loading fire-arms.
1536 H. A. Bonneville—Bolts and rivets
1537 A. Morel—Combing wool and other fibrous material.
1538 A. More'—Traction engines.
1539 J Watts—Malt.
1540 W. Hickley — Metal screens and sieves for screening and sifting.
1541 W. E. Newton—Pipes.
1542 M. Henry—Decorticating grain and seeds, and the application of the products obtained by and materials used in decorticating.

Dated June 20th, 1863.

1543 T. Smith, T. Moore, & M. Burrell—Reels covered with silk or other suitable material used as machines for the purpose of dressing flour.
1544 Y. Meirat—Propelling vessels by water power.
1545 D. D. Kyle—Baths.
1546 G. Haseltine—Oil, more especially designed for mixing paints and colours, and new mode of manufacturing the same.
1547 R. Brownlee—Sawing machinery.
1548 P. Fassio—A system of several fire places to one chimney.
1549 G. Brixey—Cleaning spoons and forks.
1550 C. Peterson—A new material or compound applicable to the manufacture of pipes or tubes, to caulking or covering ships' bottoms, and to other useful purposes.
1551 J. L. Clarke—Turning over the leaves of music and other hooks
1552 H. Macaulay—Covers or appliances for the rims, borders, or top edges of chamber utensils, applicable also to commodes and water closets.
1553 F. Jenkin—Electric tell-tale compass.
1554 T. N Goll—Mountings or settings for precious or other stones.
1555 W. L. & T. Winans—Construction of steam vessels.
1556 W. L. & T. Winans—Couplings for propelling shafts of ships or vessels.
1557 W. L. & T. Winans—Propelling ships or vessels for ocean navigation.
1558 W. L. & T. Winans—Propelling ships or vessels for ocean navigation.
1559 W. Clark—Paper pulp.
1560 J. Booth—Winding machines.

Dated June 22nd, 1863.

1561 J. Sainty—Turnip cutter for cutting the last slice.
1562 E. Wilks—Portmanteaus and trunks.
1563 A. Twaddell—Sizeing or preparing warps.
1564 J. McLean—Treating oil from shale or other bituminous minerals and similar oils, to obtain various products therefrom.
1565 W. Snell—Cannon, with arrow-shaped projectiles.
1566 F. Boult—Obtaining patterns or designs for the arts and manufactures.
1567 L. A. Majolier—Apparatus for carburetting gases.
1568 W. Rowan—Pistons.
1569 W. Clark—Charging air with combustible vapours.
1570 W. L. & T. Winans—Propelling ships or vessels.
1571 W. L. & T. Winans—Propelling ocean steam vessels.
1572 W. L. & T. Winans—Construction or arrangement of the working parts of engines for actuating the propelling shafts of steam vessels.
1573 W. E. Newton—Printing machinery.
1574 C. T. Burgess—Reaping machines.


330°
90°
90°
90°
90°
N OF CUPOLA
Wat
Line
210
220 Feet
W. Smith

A SIX GUN ARMORED CORVETTE.

DESIGNED BY J. W. NYSTROM, C.E.

FIG 3. TRANSVERSE SECTION AT A.B

FIG. 5 SIDE VIEW

FIG 4 PLAN OF CUPOLA

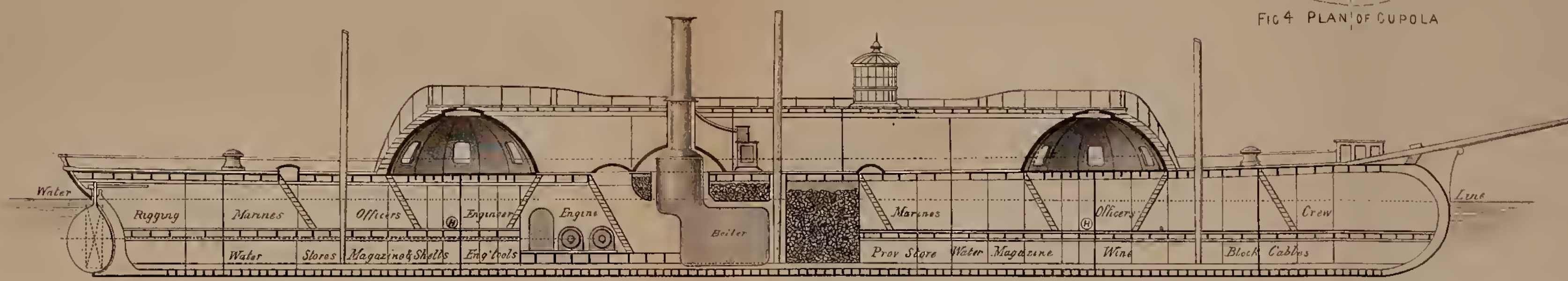


FIG. 1. LONGITUDINAL SECTION

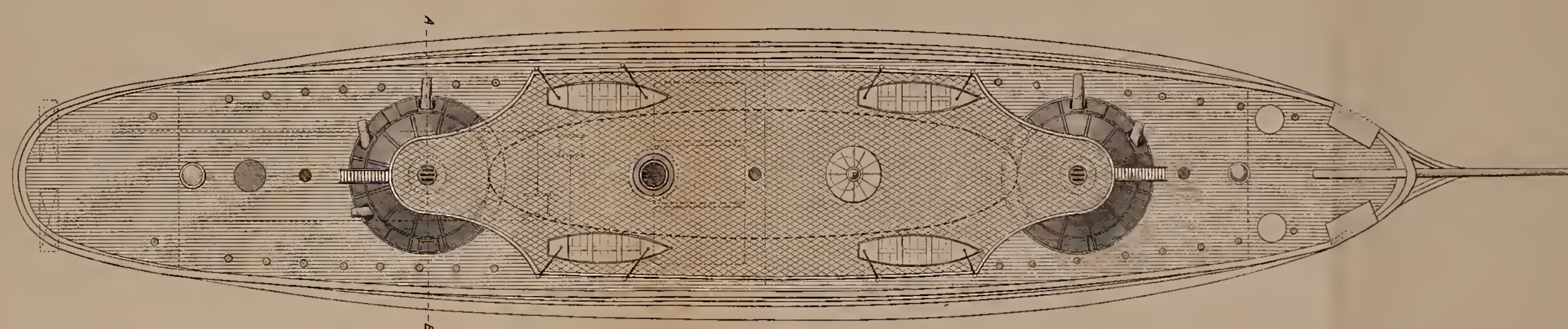


FIG 2 PLAN OF UPPER DECK.

SCALE OF FEET

W. Smith C.E. direx.

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THE ARTIZAN.

No. 8.—Vol. 1.—Third Series.

AUGUST 1st, 1863.

ON IRON-CLAD SHIPS, WITH PLANS AND SPECIFICATIONS OF AN ARMOURED CORVETTE PROPOSED FOR THE UNITED STATES GOVERNMENT.

By John W. Nystrom, C.E.

(*Illustrated by Plate* 244.)

From the *Journal of the Franklin Institute.*

Armoured ships are yet experiments, and a subject now of considerable importance in tbis country. It is a ratber difficult undertaking to combine all requirements of an iron-clad man-of-war, particularly for one of small size and for shallow water. The most important requirements are, —impregnability, speed, superior ordnance, good sea-going and sailing qualities, comfort on board, simplicity, and no complicated machinery, and lateral strength of tbe hull of the ship, all of wbich are to a certain extent combined in tbe corvette about to be described.

In August, 1861, and February, 1862, the Navy Department at Washington invited the ingenuity of the country to make proposals for the construction and building of iron-clad steamers, which was at both times promptly responded to by a great many plans, of which the corvette herein described is one of the two submitted by the writer.

The two sizes of armoured steamers which I proposed to build were constructed to accommodate the stipulations of the Navy Department's advertisement. It is, however, believed that smaller boats would answer better for the present requirement peculiar to the country, but in all cases small gun-boats are best suited for home service; a greater number could be built in a shorter time, which would be more effective in blockading the long American coast. Armoured gun-boats of 125 feet long, 20 feet wide, with only 7 feet draught of water, mounting one or two heavy guns, could go by inland navigation from New York to Fortress Monroe; they could even be made to draw 10 feet water by taking in coal and ordnance after arriving in sufficiently deep water. The object of which would be to surprise or attack an enemy's fleet at Sandy Hook, Delaware Bay, or in the Chesapeake. If the Navy Department would allow themselves to part from the Erie experiment principle and employ our present knowledge in steam engineering, gun-boats of this size could easily be made to carry fuel for six days' steaming. A number of small gun-boats are not so easily surprised, and if a blunder is made in one or more of them the risk is not so great as in a line-of-battle. They are, however, easier managed, and if damaged they can go behind islands and shoals out of the reach of the enemy's fire. An experimental gun-boat of this size could be built in two months, and if proved successful almost any number could be built in the next two or three months.

Armoured ships must yet be considered an experiment, for which a number of large ones bears a greater risk in expense and blunders. The large size armoured steamers built in European navies are intended more for service abroad, for which they are well suited and less expensive than a number of smaller ones, but our case is of a different nature.

In the Russian war with England and France, an English officer proposed a plan to attack and bombard Cronstadt with a number of small gun-boats, which was considered the most safe and effective, but peace was restored and the plan abandoned.

A corvette on the plan about to be described will be as impregnable as any iron-clad now building in Europe. As regards speed, the conditions set forth in the Navy advertisement were such that speed could not possibly be attained, for the greatest speed I can with safety guarantee is 10 knots, but am able to construct an iron-clad of the same or smaller size with 15 knots per hour. Although speed is of great importance, there are no men of war in the U. S. Navy with good speed, and some of the iron-clads lately built can hardly walk by themselves, but must have a tow-boat to help them along; also the gun-boats built on the Erie experiment principle can only walk.

The sea-going and sailing qualities of the corvette will be as good as that of any merchant vessel of the same proportions; it is in every respect a ship-shaped vessel. A man-of-war may come in battle once or twice, or say a dozen times in a lifetime; it would be improper to sacrifice comfort, health, and life for some temporary importance; in the corvette proper attention is paid to the comfort of officers and men on board by a house placed between the cupolas on the main deck. Tbis house does not interfere witb the proper management of a battle,—should it be injured by the enemy, repair it,—sbould it be shot away entirely, build a new one.

The lateral strength of an armoured ship for shallow water, requires the greatest consideration both in design and workmanship: wooden vessels can hardly be made strong enough for that purpose. An iron-clad now building at tbe Philadelphia Navy yard will hardly bave lateral strength enough for the waves of tbe Delaware breakwater.

Specifications of an Armoured Corvette with six 11-inch guns.

In the accompanying Plate 244, Fig. 1 is a longitudinal section, showing the internal arrangement, and Fig. 2 a plan of the boat; the arrows sbow the limit of angle in whicb the guns can be trained in each port hole.

Fig. 3 is a transverse section through the line A B, Figs. 1 and 2, showing the armour guards and cupola with one gun. The armour guards above the water line are at an angle of 45° and of 5 inches thick iron plates; under the water-line the guards are at an angle of $67\frac{1}{2}$°, and of three inches thick iron plates.

Fig. 4 is a plan of tbe cupola, showing the three guns, of which it is proposed to use two at a time, and have one for reserve in case the others should got injured or hot during the firing. With some practice it might be possible to employ the three guns at the same time, depending on the enemy's position.

Fig. 5 represents the outer appearance of the corvette, with two armour cupolas on deck, in each of which are to be placed three 11-inch guns.

Dimensions of the Boat.

Length on the water-line	225 feet.
Breadth of beam moulded	40 „
Extreme breadth over guards	45 „
Draft of water	12 „
Greatest immersed cross section	436 square feet.
Greatest cross section including guards ...	450 square feet.
Displacement	2125 tons.
Speed in miles per hour	10 knots.
Horse-power of engines	900 horses.

The corvette to be made wholly of iron, with two propellers, and schooner rigged.

Description of Iron Work.—Keel.—The centre keel to be made of plate iron $1\frac{1}{4}$in. thick, by about 2ft. wide, bent to suit the form of the boat; also two keels of solid rolled beam iron 12in. deep, one on each side, as shown in Fig. 3.

Sternpost to be of wrought iron in one piece, with a stuffing-box and heel for the rudder, as shown in Fig. 1, and to be made in one piece from deck to keel, as shown in Fig. 1.

Plating.—The hull to be of $\frac{3}{4}$in. plate iron, lapped longitudinally and butt-jointed vertically, the butts to be double riveted in each plate. The streaks to be about 3ft. wido from centre to centre of rivets, except in the stern and bow, where it diminishes according to the ordinary mode of iron shipbuilding. All the seams to be caulked, in and outside. The $\frac{3}{4}$in. iron plating to extend in about 150ft. under the guards, the balance at the stern and bow to be plated with 4in. thick iron plates above the water line; to 6ft. depth, to be plated with 3in. plates; from 6ft. under water line the keel to be plated with $\frac{3}{4}$in. iron, except in the bow, where one streak from 6 to about 9ft. depth to be 2in., and from 9 to about 12ft. depth to be 1in. thick. The butt pieces in the armour streaks to be $1\frac{1}{2}$in. thick, screwed on with $1\frac{1}{4}$in. tap screws, $2\frac{1}{2}$in. into the 4in. armour plates; under the water-line the butt pieces are to be rivetted.

Ram.—The ram of the corvette is to be formed by the armour-plates, terminating in the form of the stem, as shown in Fig. 1. The object of making the ram in this round shape, is to distribute evenly on the vessel the shock of a collision; also for preventing the ram sticking fast in the vessel run into. The rams now made for some vessels in the navy, with a small piece of iron sticking out from the stem, is a rather unsafe contrivance; should it stick fast for only one minute, the enemy's vessel will likely be hung upon it, which may give time enough for the enemy to

board us, and should the enemy's vessel have a velocity forward while attempting to run into it, the ram may be broken off and injure our vessel more than the enemy. The *Merrimac's* ram was broken while running into our vessels in Hampton Roads.

Frames.—The frames to be spaced 18in. apart; every other of beam iron, solid rolled 12in. deep, and every other of beam iron $\frac{3}{4}$ (6 + 4) inches. The frames to be in as long pieces as possible with broken joints. In the most curved parts of the stern and bow where it is not possible to bevel the beam iron, the frames to be made of $\frac{3}{4}$ (6 + 4) inches angle iron; also the frames on the bulkheads to be of the same iron.

Beams.—The beams to be of beam iron, solid rolled, 12in. deep, spaced 3ft. apart, one on every other frame, bent at the gunwales in continuation of the frames, as shown in Fig. 3. The joints of the frames and beams to be riveted with butt pieces $\frac{3}{4}$in. thick by 3ft. long, one on each side, with one inch rivets. The beams over the bulkheads to be of angle iron $\frac{3}{4}$ (6 + 4) inches. Under deck beams to be 6in. solid rolled beam iron, riveted to the frames as shown in Fig. 3. Under each cupola to be six intermediate beams of 9in. solid rolled beam iron, as shown in the section fig. 1.

Stringers.—The gunwale stringer to be of plate iron 1 (12 + 12) inches, firmly riveted to the iron deck and side of the vessel, as shown in Fig. 3. The stringers to circumscribe the entire vessel.

Keelsons.—To have 3 keelsons, the centre one to be of solid rolled beam iron 12in., and one on each side of 9in., spaced 9ft. 6in. apart, as shown in Fig. 3. The keelsons to be firmly riveted to each frame.

Longitudinal Beams to be of 9in. solid rolled beam iron, spaced 9ft. 6in. apart, and firmly riveted to the deck beams.

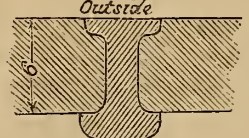
Bulkheads.—To have five water-tight bulkheads of $\frac{1}{2}$in. iron diagonaled on both sides with angle iron $\frac{1}{2}$ (3 + 2) inches, as shown in Fig. 3.

Decks.—To have two decks, the upper one to be of $1\frac{1}{2}$in. thick plate iron next to the beams, butt-jointed in all seams with $\frac{3}{4}$in. butt pieces; the longitudinal seams to run in one line, and broken cross seams. The iron deck to be covered with 8in. thick planks, screwed fast from underneath. The under deck to be of $\frac{1}{2}$in. iron with longitudinal lap seams and butt-jointed cross seams, covered with 4in. thick plank, screwed fast from underneath.

Rudder.—To have a balance rudder of wrought iron, fitted so as to be protected from enemy's shots. The rudder to be worked either in the pilot house on deck, or under deck in the mariners' room abaft. I have made this kind of rudder on several steamers in Russia, and found it to answer exceedingly well; it has many advantages above the single rudder,—it is easier managed, the vessels steer better with it, and it is less effected by the sea—Fig. 1 shows how it is arranged.

Armour Cupolas.—To have two armour cupolas on the main deck, of a spherical form 25ft. diameter at the base and 10ft. high. The armour-plates to be 6in. thick, jointed in 12 segments with 8in. solid rolled beam iron, as shown in the accompanying woodcut. Each cupola to have six

Outside



Inside

port holes, in which the guns can be trained in a horizontal angle of 90°, and vertically about 47°. The port holes to be 3ft. wide by 4ft. high, covered with a sliding shutter $4\frac{1}{2}$in. thick, as shown by figs. 3 and 4. The shutters to be worked from the inside. Each cupola to admit firing in a horizontal angle of 330°. The tops of the cupolas to have a hatchway 6ft. in diameter, covered with a plate $4\frac{1}{2}$in. thick, which latter to have a hole 2ft. in diameter, covered with an iron grating. Cupolas of this description are considered strong enough without any backing of wood, which latter would greatly interfere with the proper training of the guns. The spherical form renders them as strong as 9in. thick flat iron, and exposes the least possible surface to the enemy.

Armour Guards.—The armour guards to extend about 185ft. on each side of the boat; the armour plates to be 5in. thick, placed on wood at an angle of 45° from the water-line to the bulwark, as shown in Fig. 3. The plates to be fastened with tap bolts from the gunwale stringer, and with screw bolts at the lower edge or water-line, through the wood to the hull of the boat. The armour plates will be 6ft. 6in. wide, and in as long pieces as possible, but not less than 10ft. The lower armour plates to be 3in. thick, by 5ft. wide, placed at an angle of $67\frac{1}{2}$°. The wood backing to be of the hardest dry oak. The ends of the armour plates to be butt-jointed, but not riveted; under each cross-joint of the 5in. plates to be laid a butt piece 2in. thick by 9in. wide, fitted into the wood, and under the 3in. plates a similar butt piece $1\frac{1}{2}$in. thick. The guards to extend on each side to where the armour plates of the stern and bow commence, so that nothing of the $\frac{3}{4}$in. plating will be exposed.

An armour plate placed at an angle, increases in horizontal thickness as the *secant* of the angle of inclination to the vertical plan. On this principle English engineers argue that a vertical plate of the same horizontal thickness as the inclined one has the same strength: which theory will hold good as regards lateral strength,—but it is the reflecting power which is taken advantage of in the inclined plate. The reflecting power is in proportion as the *tangent* of the angle of inclination; that the *secant* and the *tangent* added together, and the sum multiplied by the true thickness of the inclined plate, will give the relative value to the vertical one. The lateral strength of an armour plate is in proportion as the square of the thickness when the breaking force acts slowly,—but in the sudden shock of a projectile, the inertia of the armour plate acts as a die in a punching machine, where the resistance of the plate is in proportion direct as the thickness.

Deck Fittings.—Bulwark to be made of wood boarded with 3in. plank, intended to be made fast and not to be saved in a battle, but should it be desired to make it removable it can easily be made so.

Capstans.—To have two capstans, one forward and the other abaft, arranged so that each can be worked by any number of men from 1 to 16, without change of gearing or other complicated machinery; also to be made so as to pinch hold of any size of chain or hemp cable.

Deck Lights.—To have deck lights to the officers' and mariners' rooms, as shown in the plan, Fig. 2,—with frames ground water-tight in the deck, and arranged so as to be easily opened for ventilation under deck; also to be provided with stand pipes of about 2ft. high above deck, for ventilation in rainy or stormy weather.

Davits.—To have two anchor davits in the bow, and eight boat davits, two for each boat, as shown in Figs. 1 and 2.

House on Deck.—To have a house on deck of an elliptical form, as shown by the strong dotted lines Fig. 2; length 85ft. by 20ft. wide, to be made wholly of iron about $\frac{1}{4}$in. thick. The window shutters to be made of $\frac{1}{2}$in. iron, perforated with rifle holes. The roof beams of the house to be made of angle iron $\frac{3}{8}$ ($2\frac{1}{2}+3$) inches, covered with iron plates $\frac{1}{8}$in. thick, on the top of which to be wooden boards $1\frac{1}{2}$in. thick. The house to contain two kitchens, dining room for officers, cabin, &c., and arranged to suit the requirement. The top of the house to be circumscribed by a brass railing. To have two iron stairways, one forward and one abaft of the cupolas. The house is not intended to be saved in time of battle: if a ball should strike it there will only be a hole. All the furniture in it to be made of iron or other incombustible materials, that it cannot take fire.

Water Closets.—To have two water closets on the fore deck, mounted on hinges, so that they can be felled down when it is required to fire forward. Also water closets under deck with pumps.

Pilot House.—To have a pilot house made wholly of iron, located as shown in Figs. 1, 2, and 4. During a battle the helmsman is stationed in the mariners' room abaft, and is directed by a dial worked from either of the cupolas.

Rigging.—To be three-masted schooner-rigged, as shown by Fig. 5. All standing rigging to be of wire rope. It is schooner-rigged for the sake of making it simple, and the least possible number of ropes.

Life Boats.—To have four life boats of the most approved form, complete, with oars.

Hatchways.—To have nine hatchways, covered with spherical armour plates as shown in Fig. 1. The two hatchways in each cupola to be covered with flat plates level with the floor. The combings to be of iron, riveted to the iron deck and projecting one foot above the wooden deck.

Figure-head and Bowsprit are arranged so that they can be removed in one minute, when the stem is a ram for running into an enemy's vessel.

Accommodation.—Under main deck is a space of 114ft. in length, occupying the whole width of the boat, of which 48ft. is abaft and 66ft. forward; also a forecastle of 30ft. to the stem; all to be arranged in the most suitable manner for officers, mariners, and crew. The water tanks are placed under the lower deck, as shown in Fig. 1, arranged with pumps, cocks, and pipes, as may be required.

Machinery.—The machinery to consist of two horizontal condensing engines, working separately, each on a propeller shaft, as shown in Figs. 1 and 2; to be of the most simple construction and most efficient in its performance, arranged with expansion, superheating of steam, and fresh water condenser, all up with the present knowledge of steam engines.

Dimensions of Engines.

Diameter of cylinders	42 inches.
Stroke of piston	30 ,,
Pressure of steam	50 lbs.
Expansion	$\frac{3}{4}$ to $\frac{1}{2}$
Actual horse power engines	900 horses.
Propellers, diameter	10 feet.

Steam Boilers.—To have three cylindrical boilers of the most simple construction; every part of the inside to be accessible for cleaning.

Outside diameter 9 feet by 15 feet long.

Area of fire-grate	96 square feet.
Fire surface	2880 " "
Consumption of fuel per hour	2450 lbs.
Consumption of fuel per day of 24 hours	26·3 tons.
Consumption of fuel per seven days	160 "

Ventilators.—To have two ventilators (fans) in the engine-room, each 42 in. diameter by 15 in. wide. Air pipes to lead under the fire-grates, between decks and cupolas, as may be required for ventilating the ship.

Donkey.—To have one donkey engine with double-acting pump, arranged with cocks and pipes, so as to be used for feeding the boilers, bilge-pump, and fire engine.

Propellers.—To have two brass propellers 10 feet in diameter, each with four blades, arranged on the shafts so as to be easily shipped or unshipped as may be required at sea.

Coal-bunkers.—To have coal-bunkers divided into two water-tight compartments, with capacity for 100 tons of coal.

Ordnance.—The ordnance to consist of six 11-inch guns, three in each cupola, mounted on carriages made wholly of wrought-iron. The gun carriages to be mounted each on three wheels on vertical spindles turned in the direction the gun is desired to be moved. The two wheels under the gun to be turned by a worm screw, and the hind wheel by a lever; the course of the gun to be steered by the lever both in the recoil and when moving it. The floor in the cupolas to be made of iron and perfectly flat, that the guns can be hauled on it in any direction. When the gun is to be fired, the two wheels are turned crosswise with the screw, the recoil is then taken partly by the friction of those wheels on the floor, and the balance by a friction wheel around which is a chain or hemp cable fastened with one end in the cupola. By this arrangement the guns can easily be trained in a horizontal angle of 90° in each port-hole. The axis of the guns will be only 7 feet above the water-line, for which it would rarely be required to dip it under the horizon, but should it be required to fire in the direction *ab* Fig. 3, the enemy must be very near, when the bulwarks is of little importance; fire it away, and the projectile will strike the water at a distance of 19 yards. The guns can be elevated to an angle of 35°. At the circumference in the cupolas are six holes of about 14 in. diameter, for handing up ammunition during firing. If more complicated gun carriages are adopted, it will necessarily throw out one of the three guns in each cupola.

Under the cupolas are steam hoisting machines H, Fig. 3, composed simply of a cylinder 12in. diameter by 15ft. stroke, to be used for hauling the guns, which dispenses with a great number of men and confusion in the cupolas. With 50lbs. of steam, the machine can pull 2½ tons.

The principal armour plates in the vessel herein described are independent of the hull of the same. Should it at any time be desired to dispense with the heavy armour, it can easily be removed, and there remains a comfortable and well proportioned steamer. It is practically demonstrated by the *Warrior* that it is not good to make the principal armour plates constitute the hull of the vessel, for the difficulty of keeping it tight after having worked in heavy sea. It is also believed that it is not practical to combine iron and wood in the hull of an armoured vessel, particularly for shallow draft, but even the size of *La Gloire* has proved a failure in that respect, and the objection will become more serious for lighter draft. A vessel can be considered a long girder, of which the strength is in proportion as the square of the depth. Neither is it practicable to make water-tight bulkheads and iron decks in a wooden vessel, for one material will tear the other to pieces in a heavy sea.

It may be remarked that the anchors and propellers are not protected by a bill and tail as in the Monitors; to which I beg to reply that if the tail really protected the propeller, and if it could be made so as not to injure the speed and sea-going quality, and not endanger the safety of the ship, it would be proper to put such a thing on; but, as long as that is doubtful, it is preferable to avoid the trap, in consideration that it is better to lose both the propellers in a battle than to have the vessel foundered at sea, before it reaches the enemy. It is of equal importance to get safe into a battle as to get safe out of it—both the purposes should be equalized and not neglected. The temporary importance of the bill and tail make the vessel more unsafe out of battle than in the battle. The chance of a propeller being hit in the water is very rare; at any rate, it would be better to make the propellers of cast iron, and with at least four blades each, so that if it should be struck by a projectile, one blade may break off without further injury to the shaft or the stern-bearing. Two propellers would have eight blades, and suppose that even seven of them were shot away, still the steamer would make a good speed with one blade left. If a blade of a brass propeller is struck, its strength does more harm to the shaft and stern of the vessel than if broken off; and it may bend so as to prevent the propeller from turning in its determined space.

It will require twelve months to complete such a vessel as that which I have described.

REFLECTIONS ON THE EXISTING BRITISH COINAGE.

To the present Government is due the credit of having effected a most important and valuable reformation in the inferior denominations of the British coinage. The heterogeneous, cumbrous, and sadly deteriorated copper pieces of money, which were so long a reproach, and, indeed, a nuisance to the community, have almost entirely disappeared from the channels of circulation, and in their place we have a convenient, uniform, and not inelegant coinage of bronze. This change has been made in a comparatively short space of time, and it exhibits in a favourable light the mechanical resources of the Royal Mint.

It may be permitted us to hope, however, that the Ministry under whose auspices the transformation of the timeworn copper currency into a more durable one of bronze has taken place, will not rest satisfied with their labours in this direction. The re-coinage of which we speak should be regarded in the light of a highly successful experiment, which points the way to other and yet more momentous improvements, rather than in that of a final measure of monetary reform.

What is now required is that the superior coinages—those of gold and silver—should also be re-cast and re-modelled. With reference to the highest denomination of coin current in this country—the sovereign—and which is in its way a fair specimen of Imperial Mintage, we have some objections to offer. The first of them is that the obverse impression does not represent at all faithfully the features of her Majesty the Queen. The die engraved by the late W. Wyon, in 1837, for imprinting the coin, was at the time named an excellent work of art, and it transferred with much fidelity the lineaments of the royal face to the discs of metal stamped at the Mint. A quarter of a century has passed away since the Queen ascended the throne. The die which in 1837 did duty by coining sovereigns bearing "the image and superscription" of Victoria I. is actually employed in this present year 1863 in the same operation! Is it not high time that the old die should be placed on the shelf of the Mint Museum, and that a new one should be engraved to take its place in the Mint presses?—a die not representing our loved Monarch as she was when a girl, but as she is now.

As it is, the Mint is engaged in coining falsehoods, and thus is lying to posterity! The same remarks apply to the coinage of half-sovereigns.

The reverse of the sovereign has a certain amount of beauty about it undoubtedly, but it is a fair matter for consideration as to whether, if the obverse of the coin were remodelled, a more artistic and elaborately engraven design should not take the place of the reverse. A completely distinctive character would thereby be given to the new coin, which ought also to bear its value stamped upon some portion of its surface. It would be quite possible for one of our artist-engravers to furnish such a design as should meet the requirements both of taste and utility.

Whatever devices might be selected for the ornamentation of the sovereign, the same should be adopted for those of the half-sovereign. At present there is great incongruity between the reverses of the two coins. The sovereign reverse impression comprises, as is well-known, the Royal arms quarterly, 1 and 4, England, 2, Scotland, 3, Ireland, shield plain, crowned, within a wreath formed of two olive branches tied together at the bottom by a riband, and beneath the shield the rose, thistle, and shamrock. The half sovereign, on the contrary, exhibits as its reverse the Royal shield as before, without the wreath, but mantled and crowned. Why should this strange diversity have been permitted in the first instance, and why should it not be put an end to now.

If the alterations we propose were made, the accuracy of the standards of weight and of fineness, for which the gold coins of the Royal Mint have long been celebrated, need not be interferred with. The diameters, too, of the pieces might be allowed to remain as at present. Both coins are well proportioned, a valuable characteristic, and one affecting much the durability of the coins.

It is a question whether double sovereigns would not be found a serviceable addition to the metallic currency of the present day. If introduced they might very properly be christened under the name of "Victorias," their obverse and reverse designs, corresponding with those of the sovereign and half sovereign.

There also seems to us to be no good reason why dies of identical character with those used for impressing gold coins at the Royal Mint, in London, should not be supplied to the Australian Mint, at Sydney. The latter is really a branch of the former, and its productions should be of the same stamp. The distinction which now exists between Sydney struck sovereigns, and those impressed on Tower Hill, is an anomaly which requires sweeping away at any rate, and it could well be done on the occasion of introducing a new gold currency.

We are bold enough to record our conviction, that if the foregoing suggestions were acted upon, the gold coinage of Great Britain would become, artistically and mechanically speaking, what it has long been intrinsically, the most perfect metallic currency in the world! Since the year 1851, when a number of automaton balances were introduced into the British Mint for the purpose of testing the weight of individual coins

and when other improvements were made there, no sovereign or half-sovereign forwarded from its coining presses, to the Bank of England, has ever been known to violate the legal limits of weight or of fineness. Why should not the some amount of perfection be attained to in the ornamentation of those coins? It is of the highest moment that beauty of workmanship, in our coinage, should interpose itself as a barrier to the nefarious proceedings of false coiners, as well as to demonstrate the superior talent and taste of our English artists and engravers.

We have said nothing of the gold coins of reigns previous to that of Queen Victoria, but as many of them are still in circulation, they increase the inconvenience arising from diversity of design, and strengthen our argument in favour of a reformation of the whole currency of gold.

The silver currency of the United Kingdom is, generally speaking, in a deploraby deteriorated state, and this resulting from hard work and consequent wear and tear. It is an incongruous and inharmonious jumble of coins, and its re-casting is as urgently demanded as was that of the old copper coinage.

Let us examine the various denominations composing the silver currency, and consisting of crowns, half-crowns, florins, shillings, sixpences, groats, and threepenny-pieces. Of crowns there are several varieties of each in circulation, and this fact of itself constitutes a strong inducement (not at all neglected) to the manufacturers of counterfeit coins. The oldest of the crown pieces in circulation, that of George III. has for its obverse a dexter bust profile of that monarch, the bust undraped, laureated, and the hair short. The reverse exhibits George and the Dragon within the Garter with abbreviated legend. Of the crowns of George IV. there are at least two varieties still in circulation. The obverse of those struck previous to 1826 display a similar bust profile of the king, laureated, and undraped. In those which emanated from the Mint in that year, and subsequently, the bust differs, the neck and head are much narrower in proportion, and it is not laureated.

The reverse in each case consists of St. George and the Dragon, but with minute differences of detail. That of the latter mintage is perhaps the more beautiful. St. George is represented in this on horseback, undraped, helmeted, with loose vest flying behind, in his right band a dagger, his left holding the reins; under the horse a dragon, a broken lance lying beside, no legend, date in exergue, and with edge inscription. The early crowns of this reign were the work of Pistrucci, the later ones that of W. Wyon.

Few crowns were coined during the reign of William IV., and, for the most part, these exist in the cabinets of coin collectors. It is scarcely necessary, therefore, to describe their type here.

There are two kinds of Victoria crowns in circulation. One of these is a very fair specimen of art, and the other is a very discreditable specimen. Of the former, unfortunately, few exist, except in cabinets and museums. The dies from which these latter were struck still survive, we believe, at the Mint, and we are not aware of any reason why—if crown pieces are to be retained in the British coinage—those dies should not be put into requisition, and a large issue of pieces resulting from them be made.

Of the second named crown of our present Majesty, too many are in existence. The obverse exhibits a sinister bust profile of the Queen, undraped, round the head two plain bands, hair parted on the forehead carried over the top of the ear, and all gathered together at the back of the head. The reverse comprises the Royal arms quarterly, shield plain, crowned, within a wreath of two olive branches tied together at the bottom by a riband. Beneath the shield is seen the rose, shamrock, and thistle. These coins altogether are wretched specimens of workmanship, and the sooner they are consigned to the melting pot the better. Of half-crowns of the four reigns previously mentioned there are an equal number of varieties, but as it is believed there is no intention to coin more of this denomination, it is only necessary to say that the sooner it merges into the florin the better.

Opinions are divided as to the claims of the well-known florin to public admiration, but it is an exceptional piece of money, and was only introduced as a stepping-stone to the obtaining of a decimal coinage. That desideratum does not appear to be arrived at yet, and the consequence is, that the florin has an *outré* appearance that ill-befits it for companionship with the non-decimal money in circulation.

Of shillings there are no less than six different kinds in circulation, but what the original ornamentation of some of them was it is difficult to ascertain. They have arrived at the stage of which we are the advocates, viz., uniformity; but unhappily theirs is the uniformity of plain surfaces.

Similar observations will apply to the sixpence, and this with intensified force. In these bustling days perhaps no coin is so overworked as this. The consequence is that an enormous per centage of so-called sixpences are unrecognisable as emanations from the Mint.

The inconvenience arising from the commingling of fourpences and threepences of the same diameter, but of humorously varying designs is understood, and need only be mentioned here. The fact is, that the fourpennypieces should be removed altogether from the channels of circulation and converted into twopennypieces.

We trust that a sufficient case has been made out for the interference of the Government, in respect to the re-casting and re-modelling of both the gold and silver coinages of the United Kingdom. It would be quite possible to effect the reform within a year or two from the present time if the work were set about in good carnest. If the Mint be not mechanically powerful enough for the duty, it might easily be made so, and there is no doubt that designs would be forthcoming which would approve themselves to the community at large, and reflect lustre on the artistic talent of the country. It would be no difficult task to support with further evidence the position we have assumed, but it is our honest impression that the public will join in the demand for a re-coinage of the silver and gold monies of the state, because the public are aware from practical and painful experience of its necessity. It may be trusted that the Chancellor of the Exchequer will take the initiative in the matter, as he did in that of the copper currency; and there can be but little doubt, if he does, that it will be carried forward to a successful issue.

ON MOMENTUM AND FLUID RESISTANCE.

Momentum.

There is no term used by writers on the mechanical sciences that seems more important to define than this, and none which appears to have a more indefinite meaning.

By the term *momentum*, I mean "the force accumulated in a moving body." Two terms, *momentum* and *vis viva*, are generally used to express this accumulation of force. Sometimes it is defined as a quantity varying as the weight multiplied by the velocity,—then again as half the weight multiplied by the square of the velocity, and, again, as the weight multiplied by the square of the velocity. The latter is I believe the most generally accepted theory among the leading constructors of our railroads and bridges,—our armaments,—our engines and vessels.

If this large class of most eminent men made no mistakes, or taught no errors, I would not dare to pen this article. However, I will advocate no really new dogma, as Olmstead, Playfair, and Newton are among its supporters, yet I do not wish to hold them responsible for any of my own deductions.

I will endeavour to prove that the momentum or quantity of force accumulated in a moving body, varies as the weight multiplied by the velocity; and that the resistance a moving body will overcome, varies as the momentum, and that the velocity will vary as the quantity of force expended. The laws of gravity are so well understood, and for our present purpose are most convenient. The force of gravity is a uniform force, and hence in equal times, will exert equal quantities of force whenever it is left free to act upon a moving body. Omitting to take any account of atmospheric resistance, and neglecting what are in the present consideration unimportant fractions, we find that a body near the surface of the earth left free to the action of gravity, or free to fall, will move through sixteen feet of space during the first second, and acquire a final velocity of thirty-two feet per second, and during two seconds will move through sixty-four feet of space, and acquire a final velocity of sixty-four feet per second.

By inquiring into the cause of this increased space moved through and increased velocity acquired during the last of the two seconds, we see that it is most easily explained. The uniform force of gravity is exerted on the moving body equally during each of the two seconds, yet the results at first sight do not appear the same. As we have seen during the first second, sixteen feet is moved through and a final velocity of thirty-two feet per second is acquired, while during the last second, forty-eight feet is moved through, and a final velocity of sixty-four feet per second is acquired. However, we wish to prove that the expenditure of force is the same during each second, and also, that although a body in this case moves over four times as much space in two seconds, as it does during the first of these two seconds, still the space moved through, is no true criterion of the force expended, or of the resistance overcome.

Gravity exerting its full force on this body for one second moves it through sixteen feet, and gives it a final velocity of thirty-two feet per second; this final velocity will carry the body through the next thirty-two feet during the last of the two seconds without any extra expenditure of force by gravity, but the body receiving the same quota of force during the last second that it did during the first, hence the body is moved through forty-eight feet during the last second, and acquires a final velocity of sixty-four feet per second.

Thus it appears that although the space moved though during two seconds, is four times as great as that moved through during the first of these two seconds, when a body is left free to the influence of the force of gravity, yet the quota of force expended during two seconds is not four

times as great as the qnota of foree expended during the first of these two seconds.

Hence "the actual work done," "the resistance overcome," "the mechanical effect," "the force accumulated or stored up in the moving body," "the momentnm," "the vis viva," or by whatever term we may choose to call this result of the action of the uniform force of gravity on the moving body, is only twice as great for two seconds as it is for the first of these two seconds.

At any point of descent a body would return to the height from which it fell, if all the force expended on it down to that point were left free to act upon it in an upward direction. At the end of two seconds as the velocity of the falling body is sixty-four feet per second, then let it commence to ascend at that point; during the first second of its ascent it will move through forty-eight feet. and have a final velocity of thirty-two feet per second, and during the next second it will go through sixteen feet, and have a final velocity reduced to zero.

Hence again it is true that the work done or resistance overcome in the first of these two ascending seconds, is equal to that done during the last of these two ascending seconds. Because the only resistance overcome is the uniform force of gravity which resists the ascending body with a certain definite quota of force during each second of the time it is left free to act. The time during which any uniform force acts freely on a body, and not the space through which it moves the body is the only unvarying and true criterion of the work done, or of the force stored up, or accumulated in the moving body. If the force expended by gravity during two seconds is four times as great as the force expended during the first of these two seconds, then the accumnlated force should be fonr times as great at the end of the two seconds, as it would be at the end of the first of these two.

We have shown that this quadruple force has not been expended and hence it is not accumulated. As the velocity varies as the time, then the force accumulated varies as the velocity, or as the weight into the velocity. Thus a double expenditure of force gives a double velocity, and a double velocity gives a double momentum. Hence the momentum will vary as the weight multiplied by the velocity.

If we measure the force accumnlated in a moving body by the length of time it is expending this accumulated force in overcoming a resistance uniform as to the time, then it is evident that it varies as the weight multiplied into the velocity.

But if we measure the force accumulated by the force expended in overcoming a resistance uniform as to the time—but not uniform as to the space—by the space through which a body is moved while the accumulated force is being expended, then it will vary as the weight multiplied by the velocity squared.

The former of these measures is usually called *momentum*, while the latter is called *vis viva*, and in reality there is no more difference between their meaning, than if we at one time should say a yard was three feet, and at another time thirty-six inches in length: momentum being the term used when the element time is taken into consideration, *vis viva* when space is taken into consideration. But when the resistance is not uniform as to the space, space cannot be a true criterion of the force expended; hence the term *vis viva* understood in this way is very indefinite. From this simple cause alone arises the great confusion of ideas on this subject.

Some persons may consider this a dispute about words only, but when we see authors of eminent practical abilities, such as Bourne, boldly teach that the momentum of a moving body varies as the weight multiplied by the square of the velocity, and that it is necessary to double the expenditure of force to obtain a double velocity; it is most evident that the dispute is not only about words.

It is on this hypothesis that he advances and endeavours to prove that the force necessary to be expended in overcoming the front resistance of a vertical plane moving though a fluid in a vertical direction, will vary as the cube of the velocity.

This theory is so generally believed, I almost fear that the prejudice in favour of it alone, may prevent many from ever giving this article a patient thought.

In the study of the abstruse subject of fluid resistance, my attention was first attracted to the confusion of theories taught on this vital principle of momentum. It is fit, then, that I should mention it in connexion with the present subject. The bearing that this question has on projectiles and iron-clads is also eminently practical.

Does the resistance a shot would overcome vary as the weight into the final velocity, or as the weight into the square of the final velocity, other things being equal? Our deductions would teach us to believe In the former of these measures, in opposition to the theory usually taught by practical men on such matters.

Both in steamship propulsion and in gunnery there are so many varying elements brought to bear in developing the force as well as in expending it, that it is impossible to determine the exact quota of force expended in overcoming each species of resistance.

I will conclude this article with an account of some crude experiments I have made, having a relation to this subject.

I dropped a small iron rod from the height of four feet so that it acquired a velocity of sixteen feet per second, and then dropped the same rod through sixteen feet, so that it acquired a final velocity of thirty two feet per second, and on measuring their respective penetration in sand found that the penetration varied as the velocity.

Then I dropped a rod of the same sectional area, but of half the length of the first one, from the height of sixteen feet so that it acquired a final velocity of thirty-two feet per second. Its penetration in the sand was the same as the larger one, dropping with a final velocity of sixteen feet per second. These results were not mathematically as I have stated, but the average penetration in these crudely conducted experiments is all I profess to give. To me they appeared as very conclusive evidence that the penetration of shot, other things being equal, will vary as the weight into the velocity, or as their momenta.

I also arranged a delicate steel spring with a trigger attached, so that I could let it re-act suddenly when compressed.

A weight bent it one degree, a double weight two of these degrees of tension, a triple weight three degrees. On allowing the spring to re-act at one degree of tension, it would throw a shot lying on it a certain height, but when let go at two degrees it would throw the shot to four times the former height, and at three degrees to nine times the height. Thus again seeming to prove that a double force would throw the body to a quadrupled height, and a triple force to nine times the height. The time the force of gravity would act on the respective ascending shots would vary as one, two, and three for their respective efforts.

These experiments were but rudely executed, but, in all their simplicity, they seemed to be very conclusive.

I hope a patient reading of this brief article may do something towards reconciling any discrepancy that may exist on this most important and interesting subject.

Fluid Resistance.

In this short article I will not attempt to investigate the abstruse question of fluid resistance as a whole, but simply desire to attract attention to a single phase of this most interesting subject.

If I am able to make my views distinctly understood, concerning the front resistance which a vertical plane meets with and has to overcome, in passing through a fluid in a direction perpendicular to this plane, I will have accomplished my design.

The amount of resistance for any one velocity is not desired,—but simply the relative resistance at different velocities.

The theoretical question is this: Suppose we have a vertical plane totally submerged, and moving through a fluid in a direction perpendicular to this plane but at variable velocities, how will the resistance and the power necessary to overcome this resistance vary, in order to move the plane with these variable velocities?

In order to be more distinctly understood, I will explain that I understand the resistance overcome to be a true criterion of the power expended, in whatever way this power may be developed.

The well known law always given and never disputed is: That the resistance varies as the square of the velocity.

But this law is differently understood, some understanding it to mean the resistance for a certain space moved through, and others for a certain time.

So to avoid this ambiguity of expression that is so easily mistaken, I would lay down my views of this law more explicitly, thus The front resistance that a plane moving through a fluid in a direction perpendicular to this plane will meet with, during a certain time, will vary as the square of the velocity. And that the front resistance which this same plane will meet with, while passing through a certain space, will vary simply as the velocity.

This view of the question is taken by Olmstead and Arnott, while a different view is more generally accepted by men eminent for their practical and theoretical abilities in engineering. I will simply cite two instances, Bourne, the great English author on steam engineering, and J. Scott Russell, the builder of the *Great Eastern*.

Olmstead and Arnott say, that the power necessary to be expended to overcome the front resistance of a steamer for a certain time varies as the square of the velocity, but Olmstead and Arnott were not practical men perhaps,—so Bourne, Russell, and hundreds of others who are the practical builders of our steamers, say that the power necessary to overcome this theoretical front resistance varies as the cube of the velocity.

And engineers of all kinds, who try to add just one knot more to the speed of their vessels, when they have already attained a high speed, know that the fuel expended in obtaining this extra knot is an increase of a very large per centage on the normal quantity of coal consumed.

But that to increase the speed of a vessel from half her average speed to her average speed, would increase the consumption of coal as much as

eight-fold as Bourne and the believers of the cube theory teach, is something with which my own experience for several years does not agree.

So first we will endeavour to settle the question practically in this manner. If there is to be an increase of speed of a steamer beyond her ordinary fast speed, the expenditure of power or the expenditure of fuel is increased in a greatly increasing ratio, sometimes even exceeding the cube of the velocity.

This can be accounted for by the increased inefficiency of the propelling instrument (whether it be a screw or a side-wheel), moved at very high velocities, and to the forced and incomplete combustion of the fuel. There are other causes, but these two are the principal ones.

When the vessel's speed is increased from half her average speed to her average speed, these two causes affect the results but very little; hence we may not wonder if by increasing the quantity of fuel per hour four or five-fold, it does increase the speed from half the average speed to the average speed. It is an experiment I have frequently tried with these results.

But let the practical question be settled as it may, for the present the theoretical front resistance is what we wish to consider.

The reasoning on this subject is this: If, during a certain time, we double the velocity of the plane we double the number of particles struck during this certain time, and also strike each one with a double velocity.

As the resistance varies as the number of particles struck, multiplied by the velocity with which they are struck, we have this fourfold resistance for this certain time accounted for. Or we have a reason for this law; that the resistance to our plane for certain time will vary as the square of the velocity.

If the resistance for a certain time varies as the square of the velocity, the power which will be necessary to be expended during this time to overcome this resistance, will also vary as the square of the velocity.

And from this it is also deduced, that the resistance for our plane moving through a certain space as well as the power that is necessary to be expended in overcoming this resistance varies as the velocity simply.

Hence, practically speaking, if the front resistance of a steamer was alone to be considered, to double the speed while going from one part to another, would require an engine of the ability to develop a quadrupled quantity of power during a certain time, but consuming only a double quantity of fuel.

The quadrupled increase in the engine's capabilities to develope power would be required, in order to develope this double quantity of power required in one-half the time that the engines would have to develope it, if the steamer was moving at the slower speed.

Hence, to double the speed of a steamer, if the front resistance was the only resistance to be overcome, and if there was no direct loss of power on account of the increased velocity of the engines or forced combustion of the fuel, then the quantity of fuel consumed to drive the steamer at a double speed for a certain space would have to be increased two-fold only, and this double quantity of fuel would develope from our four-fold increased engine only a double quantity of power.

If this four-fold increased engine in our fast steamer was to develope power for the same length of time, as the single engine in the slow steamer, then the quantity of fuel consumed, or power developed, would also be increased four-fold.

These exact results in practical steamship propulsion, of course, could not be expected, but because they are not realized we are not obliged to arrive at erroneous conclusions on the whole subject.

Although the angular entrance of an ordinary steamer decreases the front resistance to a very great extent when compared with the resistance the bow would meet with if rectangular, yet the principle holds good, that the particles of water must be driven from a bow of a certain form, with velocities varying as the speed of the steamer.

Now, I will endeavour to explain the deductions from experiments on which the advocates for the cube theory base that principle.

I will endeavour to prove most conclusively why it is that this erroneous theory receives so general acceptance.

By direct experiment it has been shown, that if a weight be attached to a cord running over a pulley, and then made fast to a body floating in a fluid, so that the descending weight will pull the floating body through the fluid with a certain velocity, then, to double the velocity of this floating body, the weight must be increased four times.

And as at this double velocity the large weight would have to move through twice the space to overcome the resistance of the floating body for the same length of time, it is estimated that the power developed by the force of gravity acting on this descending weight, in order to double the velocity of the floating body for a certain time varies as 8 : 1.

Thus, weight 1 multiplied by space 1 is said to represent the mechanical effect of the small weight; while weight 4 multiplied by space 2 is said to represent the mechanical effect of the large weight.

A most accurate and careful set of experiments were made by the French Academicians D'Alembert, Bossuet, and Condorcet, in 1781, and the results of these experiments seem to have been so conclusive as to have been received without doubt. The height through which the weight fell, multiplied by the weight, varied nearly as the cube of the velocities with which they drew the float through the fluid.

However, these experiments are not the only foundation for the cube theory, as Bourne, in discussing this subject, asserts that Newton is wrong in thinking that if a body is put in motion by an expenditure of a certain definite quota of power, then to put this same body in motion again with double its former velocity will require but a double expenditure of power.

Bourne's theory is, that if a body is put in motion by a certain expenditure of power, then it would require a quadrupled expenditure of power to give a similar body a double velocity. This theory he thinks he proves conclusively by the laws of gravity, and if his views on that subject are not erroneous, he undoubtedly proves this theory on momentum is correct, as well as his cube theory on fluid resistance.

In the preceding article on momentum, I have asserted:—"That the generally received criterion of 'work done,' or 'mechanical effect,' 'power expended,' or resistance overcome,' being the space through which a body was moved, was erroneous."

The height through which a body is raised multiplied into its weight is a gauge for "work done" or "mechanical effect," more universally used than a two foot-rule is for measuring dimensions.

If an incorrect gauge is used, no wonder that there are some striking discrepancies in conclusions.

If we can determine the actual resistance overcome, when a body is moved through a space during a certain time, that, and that only, will be a true, unvarying criterion for mechanical effect.

It is well determined, both from theory and experiment, that if an initial velocity be given to a body in an upward direction, sufficiently great to raise it 16 feet during one second, it will overcome the uniform resistance of gravity for one second. Then to give a similar body double this initial velocity, it will raise the body not 32 feet, but 64 feet, and be two seconds in doing this work, or it will overcome the uniform resistance of gravity for two seconds.

Hence, although the spaces through which these bodies are raised vary as 1 : 4, the resistance of the force of gravity overcome, or the power expended in overcoming this resistance of the force of gravity varies as 1 : 2.

No example can be more simple or more striking. If it fails to convince, reading the remainder of this article will, I fear, be time lost to the reader.

It is on this false criterion of mechanical effect—"weight multiplied into space," that Bourne defiantly plants his flag as an advocate for the truth of the cube theory.

This false criterion receives universal approbation from all writers on mechanics. It is taught in all our books, and from the desk of every professor of natural philosophy in our schools.

If this is not sufficient evidence to rob it of even a shadow of error, then we may have the temerity to boldly question its correctness. My "*ipse dixit*" is not worth the paper on which it is written—and perhaps it will be said my reasoning is on a par with it in value, but if my reasoning on this subject will bear the test of examination, then our books on mechanical science will stand a slight overhauling to advantage,—and our philosophical professors may re-write some of their lectures. For several years I have particularly noticed the discrepancy on this subject, and have anxiously and patiently waited for some master mind to unravel the mystery. Page after page has been written, but no one appears to have drawn the curtain to one side.

If success should crown my effort, I shall be sufficiently repaid for my seemingly independent course of thinking, and thus trifling with the opinions of high authorities.

The criterion of resistance overcome is the pivot on which the whole subject beautifully turns.

If in any of the experiments recorded where the velocity varies as 1 : 2 we multiply the height through which the weights descended for a certain time, by the weights, while they were overcoming the resistance of the floating body,—to obtain the mechanical effect of the force of gravity developing power—then it would vary as the cube of the velocity.

But, if we multiply the times during which the uniform force of gravity was developing power (which times being equal), into the weights, which varied as 1 : 4, to obtain the mechanical effect which the uniform force of gravity developed, then it would as 1 : 4, or as the square of the velocity simply.

This fact is elegantly illustrated in the experiments made by the French Academicians as recorded in their Memoirs.

They may not have observed it particularly,—as this series of experiments were introduced to prove the cube theory beyond a doubt, and are referred to for such proof to this day.

If it is true that the force of gravity does develope four times as much power when it draws a body through a space of 64ft. in two seconds, that

it does in drawing it through 16ft. in the first of these two seconds, then the cube theory is correct.

It is evident that experiments and deductions made with a false criterion of mechanical effect are vitiated in their conclusions.

With this understanding, several years ago, I made an experiment on fluid resistance with the following results;

The experiment was a rude one however, the details of which I have lost, and with my present facilities, I cannot repeat it.

Two light metallic planes were so weighted as to keep the top side uppermost, and of a specific gravity but little greater than the water, and so filled in on the under side as to diminish the resistance of the water dragging after them as much as possible. So that when these planes were drawn up by cords from a depth of water of about 20ft. the great portion of the resistance was front resistance.

By a crank and axle having two diameters varying as 1 : 2, a coincident motion was obtained for each, but with velocities varying as 1 : 2.

A common spring balance was secured on the cord between the surface of the water and the axle.

This spring balance self-registered the maximum strain on each side.

This strain on the cords as registered by their respective balances varied nearly as 1 : 2,—and not as 1 : 4

To me it seemed to prove conclusively that the resistance for these planes, while moving during a certain time, varied as the square of the velocity,—and for a certain space as the velocity simply.

Hence the power required to overcome the resistance for a certain time would vary as the square of the velocity, and for a certain space as the velocity simply.

The practical bearing of this subject on the grand question of steamship resistance and propulsion, is very important, to say nothing of its influence on other great engineering questions.

The settling of it beyond dispute is a subject well worthy of the attention of those whose authority on such subjects could be received with confidence.

My authority, I know, is worthless,—my views on mechanics are bounded by narrow limits, and my attainments are very moderate; therefore, I should deeply regret leading any one astray,—if my firm convictions on this subject are erroneous.*

ROYAL NAVAL ENGINEERS.

In our last number we referred to a document put forward by the Royal Naval Engineers. We are glad to know that our comments upon that document have been the means of drawing attention to this subject in quarters where information is much needed.

Our attention has since then been directed to some of the charges which appear to have been suggested and recommended by the gentleman who was examined on behalf of the engineers of the navy, before the Committee of the House of Commons on Naval Promotion and Retirement.

The most important change recommended by the gentleman referred to, (Mr. Rumble, inspector of steam machinery at Sheerness,) relates to the reduction of the number of engineers required in our ships of war, and the substitution of a class of "skilled workmen" to do the actual mechanical labour involved in the various repairs which are from time required in the steam machinery.

This suggestion, which by the way is not entirely a new one, appears to have arisen out of one of the questions concerning the present standard of qualification required of candidates for entry into the navy. Members of the committee seemed to think that the proposed elevation of the standard of examination, would be the means of reducing the number of candidates from whom the Admiralty at present are able to select.

While on this question of examination, we must confess that our impression previously has been, that the statement of qualification required by the Admiralty was of such a nature that the examining officers were not limited in any way as to the extent to which they might test the professional abilities of the candidates, but that their tests were too frequently applied in so lax a way as to admit individuals of very questionable ability, either as regards theoretical knowledge, or mechanical skill, while the general education and intelligence of the candidate was never tested or inquired into at all. We have always looked upon this subject as a very fruitful source of evil in the service.

Surely, there is not really anything incompatible between sound general education and the possession of that amount of mechanical skill which every marine engineer ought to possess. Professional knowledge and mechanical ability are, doubtless, the primary essentials for an engineer, but we believe if better means were taken to ensure some higher educational status in the candidates, we should hear less of that unfair and invidious treatment of which the class has so long had to complain.

This absurd idea of a sort of incongruity between gentlemanly manners and work, is, we fear, entertained by many of those who agree with the suggestion for the introduction of "skilled mechanics." We would warn such engineers, if they imagine that the introduction of such a class will relieve them from the necessity of possessing, and very frequently of exercising, that skill themselves, they will make a grievous mistake. It is an error to suppose that there is any real degradation in the work which is at times absolutely required of the young engineer; on the contrary, the possession of that very skill, if accompanied with the education and good manners which are essential to any one who aspires to be considered an officer and a gentleman, will be an additional claim to consideration and respect, in the estimation of all whose respect and consideration is really worth having.

One point in the examination of Mr. Rumble we would take exception to, is the proposal to draw the supply of engineers for the navy exclusively from the Dockyard Steam Factories. We believe such a course would be unfair, and at times detrimental to the public interest; many very valuable young engineers would be entirely excluded from competition; and we think the Admiralty might, with as much propriety, use our naval hospitals for the training of their medical staff.

It was suggested, also, that the proposed class of skilled mechanics, consisting of engine-fitters, boiler makers, coppersmiths, &c., should be made petty officers in Her Majesty's service. We have very little hesitation in saying that any attempt to induce skilled workmen in the above trades to go to sea as petty officers, at the rate of 2*s*. 3*d*. per day, will not, can not, and ought not to succeed. We think skilled workmen who can obtain five, six, or seven shillings per day on shore, will smile to hear that such a proposition could have been seriously entertained by any naval engineer whatever.

This question, altogether, is one of great importance and requires more consideration than it appears to have received at present. At any rate we would recommend caution in its introduction, and great care and taste in its carrying out. That the suggestion itself may be a good one, and that it may ultimately be successfully adopted, we readily believe; in fact, it does appear to strike any ordinary observer that it cannot possibly be necessary, for the management of the machinery of any single ship, to carry a large staff of scientific engineers, every one of whom expects to become an Inspector of Machinery, or, perhaps, a dockyard Chief Engineer; at the same time common sense seems to indicate that proper information should be obtained, and proper precautions taken before such a change is attempted, or the inevitable result will follow that another class of men will be introduced into Her Majesty's Service to worry the authorities with their grievances and demands for redress.

Two things appear to our minds absolutely necessary to the successful introduction of any such scheme. The first is to give the engineers, already in the service a much higher status both as regards pay and position, and by demanding a higher educational standard than has hitherto been deemed sufficient; and, secondly, by giving the proposed class of skilled workmen such a rate of pay as shall induce really decent workmen to enter, and such a position in the service as shall remove them from the possibility of being subject to the treatment at present inflicted on the stokers and engine-room petty officers now in the navy.

It cannot be doubted that to carry out, with any degree of success, such an important change will, indeed, require the hearty co-operation of the present staff of engineers, and the fear which many of these already feel lest the contemplated change should ultimately lead to the reduction of the entire class to the old position of warrant officers, might very wisely be removed by the introduction of those liberal measures which, even on other grounds, the class is justly entitled to.

Some other points in connexion with this subject, which were referred to before the House of Commons Committee, we must leave for consideration in a future number; in the meantime we commend the above remarks to the attention of the Admiralty, as being dictated by a real desire to benefit the public service as well as to ameliorate the condition of an important and a deserving class of officers.

We are glad to learn that the Admiralty have, within the last week or two, given an instalment in the matter of pay, by granting a small additional sum per day—as "charge money" or "store allowance"—to those officers who are in charge of machinery in commission.

We trust we may soon have to announce that the question of naval engineers' pay, at last, has been settled in a satisfactory manner, by a liberal improvement being made in the pay of all classes from the Second Assistant to the Inspector of Machinery.

* The above articles on Momentum and Fluid Resistance, written by Mr John A. Grier, Chief Engineer in the U.S. Navy, were originally intended for THE ARTIZAN, the author having to leave England suddenly for America before the completion of the articles. They afterwards appeared in the *Journal of the Franklin Institute*. Both articles have since been revised by Mr. Grier, and we are now enabled to reproduce them, denuded of some typographical errors which rendered some of the statements apparently very contradictory.—ED. ARTIZAN.

SCOTTISH SHIP BUILDERS' ASSOCIATION.

ON A NEW SLIP DOCK MODEL.

By Mr. Robert Duncan.

In describing the model of the slip dock cradle, with the various suggested improvements, I may previously assume that the application for slip docks for the repairing of vessels is so well known to you all, that little more is left than merely to describe my plans, with the uses that might be advantageously obtained from them; their easy application to the present existing cradles, and the general superiority of slip docks, for the repairing of vessels, over all other docks.

In the first place, the principal advantage I aim at is to do the same amount of work that is done on other slips in a shorter time, and at a comparatively less cost, which, if attained, you will all admit, is the great desideratum of the times we live in.

With reference to the model, in the accompanying illustrations, Fig. 1 is a longitudinal section, showing the cap with vessel resting on rollers. Fig. 2 is a plan of the cradle, &c. I will first draw your attention to the main or centre part of it. In external appearance there is little difference between it and the present existing cradles; but by a closer inspection, or from the drawings you will at once perceive my object, which is to simplify its removal from underneath vessels, when repairs, on the keel or otherwise, renders its removal absolutely necessary. The removal of the cap, or sliding part, will enable you to see a recess that is cut in the main or centre part. It is a cut to a depth so as the rollers that are placed in it may project a little above the flush of the side flanges, in order to prevent the under side of cap or sliding part from rubbing on the top of the side flanges, thereby evading the friction that would necessarily ensue. In the event of of the centre part being made of pitch pine, or any sort of soft timber, the bottom of recess would require to be laid with good hard British oak, or other such timber most suitable, or, in order to prevent the rollers from great friction, it might be covered with iron.

Owing to the thinness of the sliding cap, it could be made wholly of British oak, which I think is of sufficient solidity to prevent the rollers from sinking into it when the weight of the vessel is upon the cradle. On the sides of the cap are two guide flanges, that fit and work easily on sides of the centre part, and are intended to keep the cap from twisting to either side when the relieving of the cradle is being performed. The small blocks on the top of the cap are fixtures, never requiring to be raised or lowered, as on present existing cradles; on account of the accommodating nature of the hinged blocks on tops of the cradle arms,

The rollers are placed all along from fore to after part of recess, and quite close to each other, with the exception of the allowance required at fore part and at keys, for the removal of the cradle from the cap, thereby giving the cap an almost solid bearing on its whole length. The rollers would require to be of British oak or lignum-vitæ, and made of sufficient length to work easy in the recess. The flat pieces of wood that lie in the recess are intended to keep the rollers from twisting or slanting when in motion; but they can easily be dispensed with, as the distance they require to travel is so small (being about two feet or three feet at most on a working cradle). Supposing the rollers did incline to slant or twist when revolving, this could be avoided by fixing centre pivots in the rollers, as shown in the woodcut on next page, with long strips of sheet iron, and holes cut in them at the respective distances, so as the pivots of each roller would fit in them; or there could be grooves cut in the rollers, and made to fit into corresponding longitudinal guides; but I consider the plain roller quite suitable.

The arms of the cradle fit into notches in centre part, so as to give an even surface for the working of the rollers. The two preventative keys or lockers, that are placed at the most suitable position for them, owing to their dovetail shape, serve the double purpose of binding the cap and main centre together whilst vessels are being hauled up on the slip, and prevent the cap from floating from off the centre part, whilst the cradle is submerged in the water.

In order to show you the method of relieving the cradle from underneath the vessel:—Suppose the vessel to be resting on cap of the cradle, with the rollers suitably placed in centre recess, and the two preventative keys in their places, the palls that are hinged on under side of centre part of cradle and fit into the ratchets of centre rails (in the usual way), are also supposed to be down, and holding the cradle from running backward. The hauling-up chain or rods are unshackled from centre part and shackled to the cap, and securely fixed, either to a pall at head of the slip or to the engine. This done, the cradle is again eased up a little bit, in order to lift up and gag the palls; the blocks on which the vessel rests are, of course, laid along her bilges, slightly wedged, but with no attempt to raise her; and the preventative keys driven out. The screw at after part of the cradle is then shackled to it, and turned by the handle or lever that fits into holes in its boss, thereby screwing the cradle backwards, whilst the cap remains stationary, or rather falling perpendicularly with the vessel till she rests on the blocks; the cap then can be unshackled, when both it and the cradle can be lowered down the slipway for the completion of the vessel's repairs. When the repairs are completed she can in a similar manner be raised from off blocks to her original position on the cradle.

The arms of the cradle are made to turn on a pivot, which gives great ease in shipping or unshipping them, and also safety to workmen, as the pivot prevents them from falling off side parts of the cradle.

The bilge or steadying blocks placed on the arms, as shown in the woodcuts annexed, are intended to suit any vessel's bottom that may go on the slip, without further labour in altering them, as is a constant occurrence with the existing mode of bilge blocks. Their action is at once apparent. A

Fig. 1.

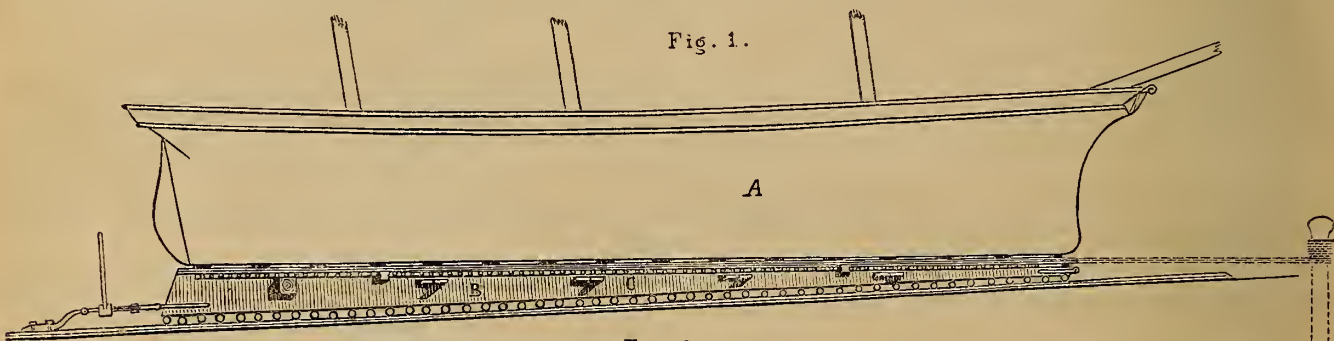
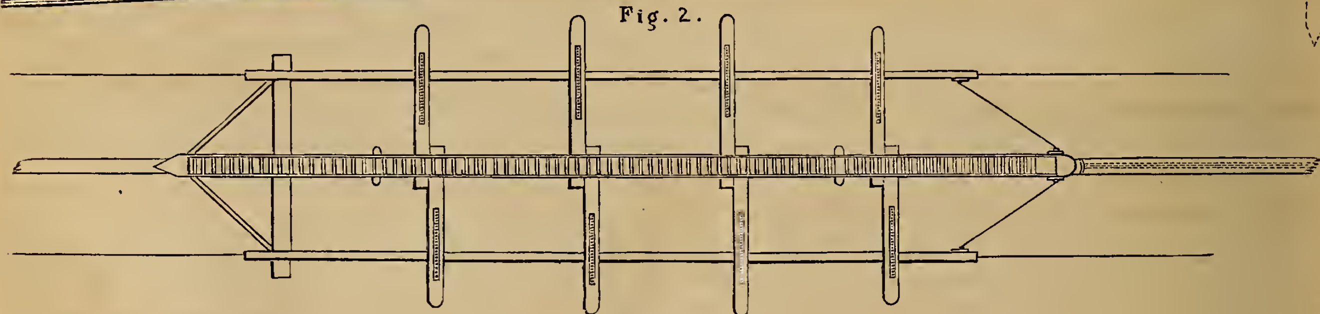


Fig. 2.



socket is fixed on the arm, and made so as it can be shifted out or in upon it; the inner end of the bilge block is fitted into this socket, and hinged by a bolt that passes through both; on the outer end of the block is hinged, by a bolt, a three-legged pall; these legs fit successively, as the block is raised up, into a ratchet indented or sunk into the cradle arm. The rope for lifting the block up to the vessel's bottom is placed at its outer end, and a line fastened to one of the legs of the pall, for the purpose of lifting it out of the ratchet, so as the blocks can be lowered, in the event of an accident of any kind occurring. The pall is relieved from the ratchet by a screw-pin that works in lower end of the pall, the point of which presses against the ratchet.

The guide-rods aft are so arrangod that they fit into what may be termed the dead wood of the cradle, and are always shipped ready for use, and easily wrought. I may here mention that the above plans could, with little expense, be easily applied to the present existing cradles.

The foregoing descriptions constitute the improvements I propose for slip dock accommodation, with the exception of the removal of cradle and vessels, especially in places where there is sufficient length to admit of more than one vessel at a time; whereas, by this plan, three could be undergoing repairs at the same time, viz., one on each side and one on centre of the slip.

New vessels could also be built on either side, and launched down the slip way, thereby saving the expense of laying launching ways, &c.

I may mention that there could be various methods adopted for the relieving of vessels from the cradle by the sliding cap other than that of of the rollers; for instance, cast metal shot or balls could be laid in the recess, or, the cap could slide on a plane surface on top of centre part by being soaped or greased, but would perhaps entail more trouble and expense in doing so.

With regard to the advantages derived from the various constructions of docks for the repair of vessels, including the graving or dry dock, the floating dock, the hydraulic dock, and the slip dock, the latter I consider most preferential for executing repairs, on account of the free current of air that passes along and through vessels when on the slip,

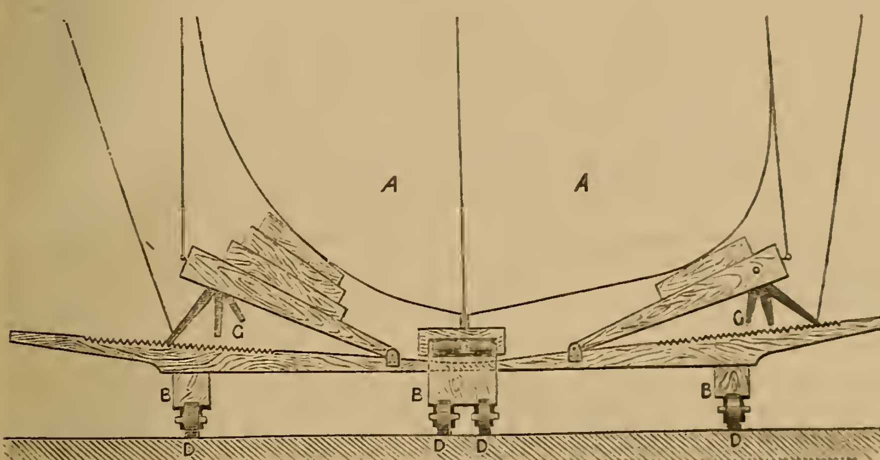


Fig. 3.

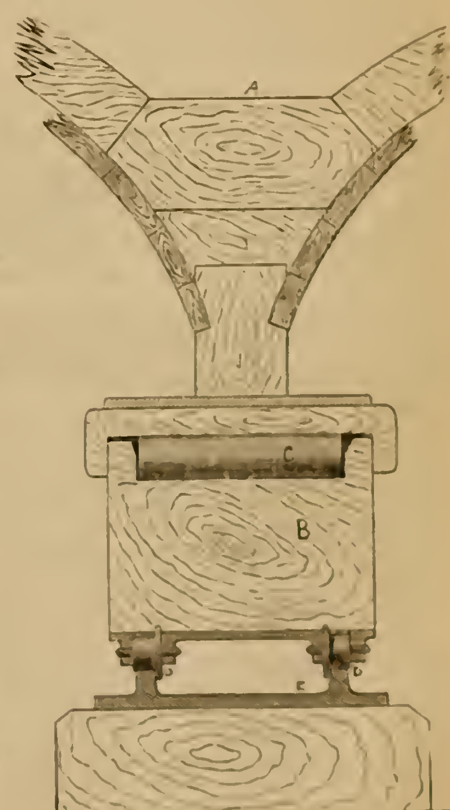


Fig. 4.

Fig. 5.

Fig. 6.

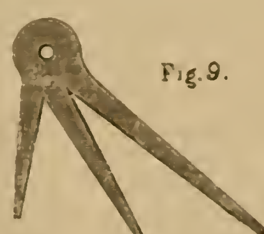


Fig. 9.

Fig. 7.

Fig. 8.

vessel to either or both sides of the slip, which plan is confined to the construction of the longitudinal rails with thin sleepers or bearers, and is as follows:—

Supposing the length of cradle required is 100 feet, I would accordingly have 100 feet of rails, and the sleepers they are attached to, made portable—that is, the under side of longitudinal sleepers thickly studded with wheels, to run on rails placed at right angles to the line of slip; the centre and two side longitudinal rails would require to be connected to each other by distance-rods, so as, when the power was applied to remove the cradle with vessels to either side, they would all move in a uniform parallel direction. Two hinged lockings would be required to keep the stationary and portable rails in a secure line of position, whilst the cradle with vessel was being hauled up.

By this plan beneficial results would be obtained for the repairs of which is a great advantage, especially for wooden vessels. When being re-classed and when freely exposed, the free current that passes through them revives and freshens the timber, and dispels the damp stagnant air which engenders dry rot. The same beneficial result is also obtained in iron vessels when being painted, as the air, for the purpose of making the paint adhere to the iron, may well be termed a good patent dryer. Similar advantages are not to be obtained in a graving or floating dock. Workmen can also continue their labours longer during the winter, by having the daylight longer by about half an hour at evening and morning, than in the two first-named docks, which is of course a great advantage to ship-owners, and well worthy of their notice.

The hydraulic has equal advantages to that of the slip dock with regard to air and light; but it has one disadvantage more than the others, by being more fraught with danger.

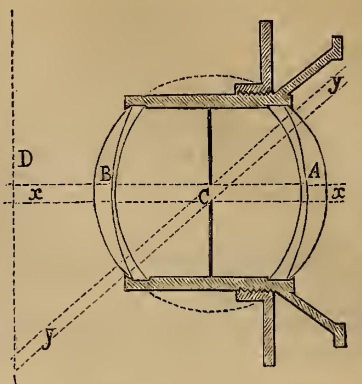
THE GLOBE LENS FOR PHOTOGRAPHIC CAMERA.

We extract from a recent number of the *American Journal of Science and Art*, the following article by Mr. Coleman Sellers, on the nature and advantage of the globe lens for the photographic camera. The subject being one that has attracted considerable attention and discussion, more especially amongst those interested in photography, we will allow Mr. Sellers to state his opinion and the results arrived at by him from the use of this description of lens:—

Photography, with the discovery of the use of collodion, seemed to leap into its present high position at one bound, at least so far as the chemistry of the art is concerned. The negatives of to-day look like the negatives of the first experimenters, and the chemical process of their production is essentially the same. But with the optics of photography the case is different—here there has been a steady improvement. The wants of the portraitists have been met by the construction of new objectives suited to the style of pictures to be produced. In these instruments depth of field with free admission of a large volume of light was what was most sought for. Theory could not dictate what shape or combination of lenses would best produce this result, and patient experiments were resorted to. The requirements of landscape photography are quite different from those of portraiture. A portrait tube may be used to take views if it be provided with a stop or small opening to limit the amount of rays passing through it and thus to deepen the field, or increase the "reach" of the instrument, as it is technically called. This involves loss of light, and consequently diminishes the quickness of its working. We hear continually of rapid or instantaneous photography, and we are often led to believe that the rapidity is to be ascribed to some wonderful sensibility of the chemicals used; but this is only partially true, and to the optician is due the most of the merit of instantaneous pictures. A portrait tube with its full opening will, in a sky-light room, produce a picture in perhaps ten or fifteen seconds. This same instrument, with the same opening and same chemicals, exposed to an extended view in bright sunlight, could not be opened and shut quick enough; the immense volume of light reflected from so large an area of space being concentrated on the same sized plate as in the first case, would be too violent in its action, and from the nature of the instrument near and distant objects could not be brought into focus at the same time.

The human eye, when the head is at rest, takes in an angle of view of at least 70° or 80°, the whole of which is not seen clearly at once, but can be examined in detail by the almost unconscious rolling motion of the eye in its socket—the actual included angle of clear vision at any one instant being only 1° or 2°. Hence a picture of a landscape, for instance, to fill the eye and seem a true representation of nature, should include an angle of at least 60°. Ordinary instruments, such as have hitherto been used, do not include an angle of more than one-half this amount, and hence has originated the complaint that photographic views represent mere patches of scenery and not pictures. I remember once standing on a bridge—camera in hand—and looking up the romantic Wissahicon. The picture presented to my eye was very beautiful—the centre a waterfall framed in on both sides by wild and rugged rocks and spanned above by the arch of a railroad bridge crossing at the tops of the cliffs. The foreground was made up of a stony bed, where danced and foamed the rapid current. I planted the camera and hoped soon to peel off from this charming view a cuticle (as Dr. Holmes says) which like plates of mica could be split and re-split for the collections of my friends. But on the ground glass I found nought but the tumbling water. No rocks, no bridge, no stony river bed—the poor camera in its empty head was incapable of taking in the whole of the charming picture. One of the dreams of the photographer has been of an instrument which should embrace a large angle and thus satisfy the wants of the eye; but, with the majority of the attempts in this direction came other evils, the greatest of which was distortion of the marginal lines. The aplanatic lens of Grubble is said to comprise an angle of 70°, but in a view before me of Trinity College, Dublin, taken with this lens, there is a curvature of the straight lines of the roof of more than one-eight of an inch in its length. Mr. Sutton's panoramic lens, a sphere of glass filled with water, includes a very large angle, over 100°, on the base line, but the pictures are produced on curved plates, which require curved holders, baths, and printing frames, and, in the case of architectural pictures, the right lines are distorted, unless the picture be bent to the curvature of the plate upon which it was taken, and thus viewed near the centre of the curvature.

The Harrison and Schnitzer globe lens consists of two achromatic meniscus lenses placed with their concave sides together, and so made that their outer curved surfaces form part of a perfect sphere and the light is admitted through an aperture placed midway between the two lenses, *i.e.*, in the exact centre of the external sphere. The annexed figure represents



one of these instruments, A and B being the meniscus lenses, and C the centre opening through which the rays of light pass. The focus of such a lens one and three-quarter inches in diameter is two and one-half inches for distant objects, measuring from the surface of the back lens to the ground glass D. The circle of light produced is five inches in diameter, and from this may be cut the ordinary 3 inches square of a stereoscopic picture. The included angle of light in the five inch circle is 75°, and in the three inch square picture cut from it is contained just four times the area of any instrument I have ever tried, suited to similar work. The remarkable property of this lens consists in its absolute correctness of reproduction. If it is used for copying purposes, the marginal lines are copied as straight as the originals, and, if a copy be made the same size as the original, the photographic copy will, if laid upon the original, match it in every line. I have said that the globe of 2½in. focus will make a circle of light of 5in. diameter. This is when a distant landscape is in focus. If it is used for copying, the circle of light increases in diameter as the object approaches the front lens and the ground glass recedes to focus, so that an instrument which will cover a given size plate for views will cover one of twice the size, when reproducing the size of the original. As the lenses increase in size and length of focus, the plates covered increase in size, and the amount of glass in the lenses bear a larger proportion to the brass work in which they are mounted, and hence the included angle of vision is increased, so that while in the 2½in. globe the included angle is 75°, in a 12in. globe (that is, one of 12″ focus) the included angle is over 90°. It has been said that the light, being admitted through a round hole in a plane plate in the centre of the instrument, must be much more intense at the centre of the field than at the margin, and some writers have stated this fault to be one of great magnitude. Practice, however, does not show the evil to be so great as they represent, if it exists at all. By reference to the cut, it will be seen, that the dotted lines x x representing a pencil of light of the diameter of the centre opening passing through the axis of the instrument, and y y representing a pencil of light passing through the same opening obliquely, doubtless the area of the centre one will be the largest, but as it passes through much thicker glass than the rays y y, may not the ultimate effect of each be equalised? I do not pretend to any knowledge of the theory of optics, and must confine myself to facts. In the trial of many of these lenses, of different sizes, I have never found the evil to exist, and all the pictures I have made with the globe lens are remarkable for the even illumination of the field. At the last two meetings of the Photographic Society of Philadelphia (February, 1863), the merits of these lenses have been discussed—full credit for correctness of reproduction was recorded to them by all; but the quickness of working was questioned by one gentleman, who stated that in broad sunlight he had exposed an engraving for several minutes and had obtained an under-exposed negative, while all others present who had tried them were unhesitating in their assertions that they were remarkably quick workers when the size of aperture was taken into consideration. A few days ago I placed in bright sunlight an engraving from the London Art Journal, and copied it on a 6½ by 8½ plate with the same size instrument as was used by the gentleman who questioned its quickness. An exposure of 25 seconds gave an impression which flashed up instantly under the developer, assuming great intensity in the light and showing unmistakable symptoms of over exposure, so that I can see no reason why the same law should not hold good with these lenses as with others, viz: that, with the same area of opening to admit light, the shorter the focus the quicker they will work. For interiors, the short focus and large angle of vision possessed by these instruments render them invaluable, and as they are provided with a revolving diaphragm plate in the centre (not shown in the cut) various sizes of aperture can be brought into position, just as the stops under the table of some compound microscopes are arranged, and thus the largest amount of light, consistent with sharpness, admitted.

In the English journals, when the accounts of this instrument were first published, it was denounced in no measured terms, as being constructed on erroneous principles, and the assertion has even been made that its very shape must give fearful distortion to marginal lines, but since it has been proved to be no failure, and its success is no longer an experiment, comes the unwilling acknowledgement: "The principle of its construction must ensure correct marginal lines," and last of all comes the declaration that it is "old, very old." Everybody had been making them for years, and there is no merit of invention due to the patentees! Granting that lenses may have been made with an external spherical

focns, as is the Sntton case, it will be difficult to prodnce a lens, made previous to the invention of this now described, composed of two achromatic meniscus lenses combined, as these are, and prodncing a like result. The theory of operation and mode of construction of the globe lenses admit of their being readily made of various focal lengths, and thus, by the use of a series of instruments, the whole inclnded angle can be made available on any size plate that may be desired; the six inch focus covering a 6½in. × 8½in. plate and the 12in. focus lens covering 14in. ÷ 18in., each including the same angle. One great advantage of short-focus lenses, when there is no spherical distortion, is in the appearance of perspective prodnced. If, for instance, we would view a machine or statne to the best advantage, we stand at such a distance from it as will admit of our viewing the whole of it in the eye at once, and can then best judge of its proportion. If now a picture be made by an instrument of long focus, it will be so far away from the object to be depicted as to make, as it were, too nearly a plane or flat view of it, deficient in perspective effect. With the very shortest focus of this new lens (the 2½in. focus), this perspective effect may be too much exaggerated, but with all the other sizes it is not, and with the globe lens and with this only have been prodnced pictures which seem to me to convey a just idea of size and proportion. The shortness of their focns adds much to their portability, as the camera is made smaller than usual, and amateur field photography with the globe lens and dry plates is a pleasure in place of labour. Its advantages may be summed up in a few words. Short focus, clear definition, wide angle of included vision, absolute correctness of copy on a plane surface, and tolerably quick work. It takes the place entirely of the orthoscopic lens, giving absolute correctness to marginal lines, while the orthoscopic was only approximately correct. It fills all the requirements of a lens for landscape and architectural work, and is wanting only in the one thing of absolute instantaneity of action.

ROYAL INSTITUTION OF GREAT BRITAIN.

AN ACCOUNT OF SOME RESEARCHES ON RADIANT HEAT.

By JOHN TYNDALL, ESQ., F.R.S.

In his former researches on the radiation and absorption of heat by gaseous matter, the speaker compared different gases and vapours at a common thickness with each other; one part of his present object was to compare different thicknesses of the same gaseous body with each other as to their action upon radiant heat. A few years ago he would be deemed a bold man who would attempt to measure the action of an inch, or indeed of many feet of gas, on radiant heat; but the present experiments commence with plates of gas only 0·01 of an inch in thickness, and extend to thicknesses of 49·4in. Thus, the greatest thickness is to the least nearly in the ratio of 1 to 5000. The apparatus employed for the smaller thicknesses was a hollow cylinder, one end of which was closed by a plate of rock-salt. Into this fitted a second cylinder, with its end also closed by a plate of the salt. One cylinder moved within the other like a piston, and by this means the two plates of salt could be brought into flat contact with each other, or could be separated to any required distance. The distance between the plates was measured by a *vernier*. The cylinder was placed horizontal, being suitably connected with a source of heat. This latter consisted of a plate of copper, against which a steady sheet of flame was caused to play.

The absorption of radiant heat by carbonic oxide, carbonic acid, nitrous oxide, and olefiant gas was determined with this apparatus, and such differences as might be ascertained from former researches were found. Olefiant gas maintained its great superiority over the other gases at all thicknesses. A layer of this gas, not more than 0·01 of an inch in thickness, intercepted about 1 per cent. of the total radiation; and the delicacy of the apparatus may be inferred from the fact that this absorption,—great, relative to the thickness of the layer of gas, but small absolutely—corresponded to a deflection of 11 degrees of the galvanometer. (It would be certainly possible to measure the action of a layer of this gas of less thickness than the paper on which these words are printed.) A layer of olefiant gas, 2in. in thickness, intercepts nearly 30 per cent. of the entire radiation. The influence of a diathermic envelope surrounding a planet may be strikingly illustrated by reference to this gas. A shell of olefiant gas, 2in. thick, surrounding the earth, would offer no appreciable hindrance to the solar rays in their earthward course; but it would intercept, and in great part return, 30 per cent. of the terrestial radiation: under such a canopy the surface of the earth would probably be raised to a stifling temperature. A layer of the gas, 3-10ths of an inch thick, intercepts 11·5 per cent. of the whole radiation. Such a layer, if diffused through a stratum of air 10ft. thick, would be far more attenuated than the aqueous vapour actually diffused through the air; still it would produce an absorption greater than that which the speaker had assigned to the atmospheric vapour within 10ft. of the earth's surface. In the presence of such facts, the arguments which we might be disposed to base on the smallness of the quantity of atmospheric vapour are entirely devoid of weight.

In measuring the action of larger thicknesses of gas, the following method was pursued:—A brass cylinder, 49·4in. in length, had its two ends stopped with plates of rock salt, and a suitable source of heat placed at one end; the rays from this source passed through the tube, and were received by a thermo-electric pile placed at its opposite end; this radiation was exactly neutralised by the heat emitted from a cube of boiling water and incident on the opposite face of the pile. The interception of any portion of the heat emanating from the source by a gas or vapour introduced into the tube destroyed the equilibrium previously existing, and the amount intercepted was declared by the galvanometer. The thickness traversed by the calorific rays was varied in the following way:—The tube was divided into two distinct compartments by the introduction of a third plate of rock salt. Let us agree to call the compartment most distant from the pile the first chamber, and that adjacent to the pile the second chamber. The experiments began with the first chamber short and the second chamber long, and ended with the first chamber long and the second chamber short. The alteration consisted solely in the shifting of the intermediate plate of salt, which lengthened the first chamber and diminished the second one by the same quantity; the sum of the lengths of both chambers being the constant quantity, 49·4in.

The absorption effected in the first chamber acting alone was first determined; then the absorption effected in the second chamber acting alone; and, finally, the absorption effected when both the chambers were occupied by the gas or vapour. This arrangement enabled the speaker to check his experiments, and also to examine the effect of the sifting which occurred in the first chamber on the absorption of the second one. The thermal coloration of the various gases was rendered strikingly manifest by these experiments. For the vast majority of the rays, for example, carbonic oxide and carbonic acid are transparent. Placing a stratum of carbonic oxide, 8in. in length, in front of a column of the same gas, 41·4in. long, these 8in. intercepted 6 per cent. of the whole radiation: placed behind a column, 41·4in. long, the absorption of the same 8in. was sensibly *nil*. So also with carbonic acid; 8in. in front absorbed 6½ per cent., while placed behind the effect was almost zero. Similar remarks apply to the other gases, the reason manifestly being that when the 8in. stratum is in front, it stops the main portion of the rays which give it its thermal colour, while, when it is placed behind, these same rays have been almost wholly withdrawn, and to the remaining 94 per cent., or thereabouts, of the radiation the gases are sensibly transparent.

An extension of this reasoning enables us at once to conclude, that the sum of the absorptions of the two chambers taken separately must always be greater than the absorption effected by a single column of the gas of a length equal to the sum of the two chambers. This conclusion is illustrated in a striking manner by the experiments; and it is further found that when the mean of the sums of the absorptions is divided by the absorption of the sum, the quotient is sensibly the same for all gases. It may also be inferred from considerations similar to the foregoing, that the sum of the absorptions must diminish, and approximate to the absorption of the sum, as the two chambers become more unequal in length, and that the sum of the absorptions of the two chambers is a maximum when the medial rock-salt plate divides the long tube into two equal compartments.

In these days a special interest attaches itself to the radiation of any gas through itself or through any other gas having the same period of vibration. The speaker referred to the results of an elaborate series of experiments on this interesting question. The experimental tube, 49·4in. long, was divided into two compartments by a partition of rock-salt. All external sources of heat were abolished, and the pile, furnished with its conical reflector, stood at the end of the tube. The compartment nearest the pile contained the gas which was to act as absorber, while that most distant from the pile held the gas which was to act as radiator. It is known that the destruction of the motion of a sensible mass of matter is always accompanied by the evolution of heat. A weight falling to the earth, and a ball striking a target, are heated on collision. The same is true for atoms, and in the present experiments the gas in the radiating chamber was heated by the collision of its own particles against the inner surface of the tube when they rushed in to fill the vacuum. The radiation was, in fact, what the speaker had named "dynamic radiation." The lengths of the two chambers were varied, the radiating column being lengthened and the absorbing one shortened at one and the same time; the sum of both was always the constant length 49·4in.

The experiments with the vapours were thus executed. Both the chambers into which the tube was divided were, in the first place, occupied by the vapour to be examined; the usual pressure being 1-60th of an atmosphere. The entrance of the vapour was so slow, and its quantity so small, that the radiation due to the warming of the vapour by its own collision was insensible. The needle being at zero, dry air was allowed to enter the chamber most distant from the pile. This air became heated dynamically, communicated its heat to the vapour, and the latter immediately discharged the heat thus communicated to it against the pile. It is quite evident, that not only does the [illegible], but that it is actually of the same mechanical character as that in which a vibrating tuning-fork is brought into contact with a surface of some extent. The fork, which before was inaudible, becomes at once a [illegible] source of sound. What the sounding-board is to the fork, the compound molecule is to the elementary atom. The tuning-fork vibrating alone is in the [illegible] of the atom radiating alone, the sound of the one and the heat of the other [illegible] insensible. But in association with sulphuric or acetic ether vapour the elementary atom is in the condition of the tuning-fork applied to its sound-board, communicating through the molecule motion to the luminiferous ether, as the fork through the board communicates its motion to the air.

The experiments demonstrate the great opacity of a gas to radiation from the same gas. They also show in a very striking manner the [illegible] of aggregation in the case of vapour. The individual molecules of a vapour may be powerful absorbers and radiators, but in thin strata they [illegible] sieve through which a large quantity of radiant heat may pass. In [illegible] strata, therefore, the vapours, as used in our experiments, [illegible] far less energetic than the gases, while in thick strata the same vapours [illegible] an energy greatly superior to the same gases. The gases, it will be [illegible], were always employed at a pressure of one atmosphere.

A few striking experiments were referred to in illustration of the [illegible] a paper lining, or a coat of varnish or lampblack, [illegible] tal tube. In dynamic radiation it is not possible to do [illegible] away with [illegible] the interior surface of the tube itself. When the tube is of [illegible]

polished within, the entrance of the air produces a deflection of 7·5 degrees, this being due to the emission from the warmed surface of the tube. A lining of paper two feet long raises the radiation sufficiently to drive the needle through an arc of 80 degrees, while a ring of paper 1½in. long placed within the tube radiates sufficient to urge the needle through an arc of 56 degrees.

The speaker finally examined the diathermancy of the liquids from which his vapours were derived, and the result leaves no shadow of a doubt upon the mind, that both absorption and radiation are molecular phenomena, irrespective of the state of aggregation. If any vapour is a strong absorber and radiator, the liquid whence it comes is also a strong absorber and radiator. The molecule carries its power, or want of power, through all its states of aggregation. The order of absorption in liquids and vapours is precisely the same; and the speaker looked forward with hope to the application of these results to other portions of the domain of thermotics.

ON THE DIRECT MEASUREMENT OF THE SUN'S CHEMICAL ACTION.

By Professor Roscoe, B.A., F.C.S.

The life of the animal may be described chemically as a process of oxidation; the tissues of his body are continually undergoing combustion; he is constantly breathing out carbonic acid gas, and thus deteriorating the ocean of air at the bottom of which he lives and moves; so that, were not a counteracting influence at work, he would, during each moment of his existence, be working his own destruction. This counteracting influence is exerted by vegetables, whose life is chemically characterised by a change opposite to that of the animal, that, namely, of deoxidation or reduction. Animals take up oxygen and give off carbonic acid; plants reverse the process, they take up carbonic acid and give off oxygen; and thus the balance of atmospheric life is kept always true.

The animal derives its power from the forces locked up in the vegetable organisms which constitute its food, and of which it builds up its tissues. When they are destroyed by the action of the atmospheric oxygen, these forces become evident either in motion of the masses, constituting mechanical action, or in the motions of the particles constituting heat, or other manifestations of energy. The animal cannot create force; he can only direct its application: he cannot move a muscle without a certain given quantity of force being changed, without a certain portion of the tissues undergoing oxidation, an amount which is regulated by the grand principle of the conservation of force—so that the total energy which the animal exhibits is regulated by the same laws which apply to the work of the steam or electro-magnetic engine. Every pound of carbon burnt to carbonic acid in the animal body evolves heat enough to raise the temperature of 8080lbs. of water 1° centigrade, or can produce a mechanical effect sufficient to raise 2784 tons one foot high.

The source of the power of the animal is evident; it lives upon the force which has been accumulated by the plant. The animal world cannot continually withdraw energy from the plant, unless the latter receives as continual a supply. The source of this energy is the sun: the plant sucks up or absorbs the rapidly vibrating solar radiations and stores them up to be given out again in the various forms of energy when the vegetable tissue is destroyed by oxidation.

It is only in the presence of the sunlight that the true function of plant life can be exercised. It is the sunlight which, acting on the green colouring matter of leaves, decomposes the carbonic acid of the air into its constituent elements, enabling the plant thus to assimilate the carbon and to turn the free oxygen back into the air.

Only those of the solar rays which vibrate the most rapidly are able thus to tear the particles of carbon and oxygen asunder, or to effect a chemical change; and these most refrangible or violet rays have, therefore, been called the chemical rays—not that there is any difference in kind between these and the other solar radiations; they all differ only in a wave length and in an intensity of vibration.

These blue rays then, falling on the green portions of plants, are absorbed to do work; their rapid vibrations are used up to set free the carbon and oxygen, and the heat equivalent to these absorbed vibrations is again given off when the carbon thus produced is burnt.

The speaker illustrated the chemical activity of the blue rays, and the inactivity of the red rays, by showing that a bulb filled with chlorine and hydrogen explodes when exposed to an intense blue light, but is unacted upon by an equally bright red light.

The measurement of the amount of these chemically active rays falling at a given time upon a given spot, must be of the highest meteorological interest, as their variation forms a most important element in the changing plant and animal-producing power of a country.

Three years ago (March 2, 1860), the speaker brought forward the results of a series of experiments undertaken by Professor Bunsen and himself for the purpose of obtaining a means of accurately measuring the chemical action of sunlight.

The measure consisted in the quantity of hydrochloric acid formed by the action of light upon a mixture of equal volumes of chlorine and hydrogen gases. The authors succeeded in arranging a most accurate and reliable chemical photometer, by help of which the laws regulating the chemical action of light were investigated, and the distribution of direct and diffuse sunlight upon the earth's surface determined when the sky is unclouded.* The delicate nature of the instrument, which the sensitive substance rendered necessary, precludes the general use of this chlorine and hydrogen photometer, and the method is likewise inapplicable when we wish to measure the total effect produced by the varying cloud and sunshine of our changing climate.

The object of the present research, carried on by Professor Bunsen and the speaker, has been to invent an easy and reliable mode of measuring the daily variation in the sun's chemical intensity which should be applicable to regular meteorological registration.

Thermometric observations, giving the mean monthly or yearly temperature of a country, by no means yield all the data required for the estimation of the true climatology of the place, or of its plant and animal-producing capabilities. For this purpose we require to have not only the amount of solar heat directly or indirectly reaching the spot; but likewise the amount of chemically active solar light which falls there. This is strikingly seen when we compare the mean annual temperature of Thorshavn (Faroe Islands) with that of Carlisle.

			Temp. Fah.	Diff.
Thorshavn	N. lat. 62° 2′	W. long. 6° 46′	45°·6	1°·3.
Carlisle	—— 54° 54′	—— 2° 58′	46°·9	

In these two situations the mean annual temperature is nearly equal, but the quantity of sunlight falling upon these two places differs most widely, and we have a corresponding difference in the true climatological relations. Owing to the constant moisture and cloudy state of the atmosphere, which the sun's chemical rays cannot penetrate, the flora of the Faroes and Shetlands is of the most limited description, only the most hardy variety of shrubs and no trees flourishing; whilst at Carlisle we have the most luxuriant vegetation accompanying a more sunny sky. Thus, too, the mean summer temperature of Rejkiavik in Iceland is only 3°·8 Fah. below that of Edinburgh, whilst the difference between the mean summer temperature of Edinburgh and London is 5°·4 Fah. Yet in Iceland no tree grows; whilst between London and Edinburgh we notice no marked difference as regards the development of vegetable life. Hence we see that places upon the same isothermal do not necessarily possess a truly corresponding climate; this can only be attained when, amongst other conditions, the places are situated upon the curve of equal mean chemical intensity.

Although many fruitless attempts have been made to construct photometers by a comparison of the blackness produced by sunlight upon photographic paper, it was found that in this way the desired end could be attained by attention to certain essential conditions.

For this purpose it was necessary to construct an apparatus in which photographic sensitized paper could be exposed to the sunlight for definite times measured by small fractions of a second. This instrument consists essentially of a pendulum vibrating about ⅔-seconds, by whose oscillation a sheet of darkened mica is withdrawn from, and brought back over, a horizontal strip of paper prepared with chloride of silver, and fixed in a constant position relative to the pendulum and sheet of mica. The time during which each point in the length of the strip is exposed is different, and the time of exposure for each point can be calculated when the length and position of the strip, and the duration and amplitude of the pendulum's vibration are given.

The strip of sensitive paper presents, after exposure, a gradual diminution of shade from dark to light, and for each shade the time of exposure is known. In order that such a graduated strip may serve as a means of measuring the chemical action of light, we require:—

1. To know the relation existing between the several tints and the intensity of the light necessary to produce such tints.

2. To construct sensitive paper which shall always possess the same degree of sensitiveness, and can easily be prepared when required.

It was found, by a long series of experiments, that it was possible, by adhering strictly to a certain mode of manipulation, to prepare standard papers which, when made, possess a constant degree of sensitiveness; so that if the same light falls upon them, the papers are always coloured to the same tint.

Experiment likewise showed that the tint attained by such a paper was constant when the quantity of light falling upon it also remained constant; so that light of the intensity 50 falling upon the paper for the time 1, produced the same blackening effect as light of the intensity 1 falling upon it for the time 50.

Knowing this law, which regulates the degree of shade of the paper, and having a surface of a perfectly constant degree of sensitiveness, it is easy to obtain absolute measurements of the chemical action of light. For this purpose an arbitrary unit of measurement is chosen, by making a standard tint or paint which can be easily and exactly reproduced at any time.

The quantity of light which shall, in a second or the unit of time, produce a blackening effect on the standard photographic paper equal to that of the standard tint, is said to have the chemical intensity 1. If the time needed to produce this same tint is found by experiment with the pendulum-photometer to be 2 seconds, then the chemical intensity is one-half, and so on.

All that is needed, in order to obtain accurate measurements of the chemical action of diffuse daylight or sunlight, is to be able to find the time necessary to effect a blackening of the normal paper equal in shape to the standard tint. This is done by the means of the graduated strip made in the pendulum photometer.

For the purpose of accurately comparing these tints, the ordinary daylight or even lamplight cannot be used, as a change would thereby be produced on the sensitive paper. A light which does not act chemically must be used: such a light is the monochromatic soda-flame. The light from this flame possesses another advantage, namely, that the unavoidable differences of colour are not seen; variation in shade alone being perceptible. The speaker exhibited the accuracy of this method of observing coincidence in shade by means of a large model of the instrument.

By help of this soda flame the coincidence of shade of the graduated strip with standard tint can be read off with the greatest precision. This fact, as well as the possibility of preparing a constant sensitive paper, is seen by reference to the following tables, extracted from the detailed paper printed in the Philosophical Transactions for 1863.

Papers variously prepared were exposed for the same time to the same light.

Each reading is the mean of several observations; identity in the numbers shows identity in the shade, and, therefore, the constant sensitiveness of the papers.

The standard paper is prepared by soaking photographic paper in a solution of common salt of given strength (3 to 100), and then allowing it to lie upon the

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* Phil. Trans. for 1857, pp. 355, 381, 601; for 1859, p. 879.

surface of a silver solution (12 NO_6Ag to 100 of water). When the strength of salt solution varies, the sensitiveness of the paper alters very rapidly. Variation in the strength of the silver-bath produces, on the contrary, but little change in the sensitiveness of the paper. Different qualities of paper and alterations of atmospheric moisture and temperature do not affect the sensitiveness of the paper.

1. *Effect of altering the Strength of the Silver-bath. Paper salted in a Solution containing 3 parts Chloride of Sodium to 100 of Water.*

Ag NO_6 to 100 of water.	Readings. Observer A.		Observer B.
12	128·6	...	129·7
10	128·7	...	127.0
8	128·7	...	128·0
6	129·7	...	130·0

2. *Effect of altering the Strength of the Salt Solution.*

Na Cl to 100 of water.	Readings. Observer A.		Observer B.
1	62·6	...	60·4
2	95·7	...	94·6
3	132·6	...	129·6
4	167·0	...	168·0

3. *Experiment showing the constant Sensitiveness of the Standard Paper.*

Paper.	Na Cl to 100of water	Intensity No. 1.		Intensity No. 2.	
		Observer A.	Observer B.	Observer A.	Observer B.
Upper part of sheet 2...	2·950	70·2	70·0	101·3	101·5
Lower part of sheet 2...	3·026	70·6	69·3	101·5	101.7
Middle of sheet 1	3·026	70·0	69·5	100·9	100·9
Middle ot sheet 3	3·000	70·0	70·4	101·0	100·0

All these papers were silvered in a solution containing 12 parts of nitrate of silver to 100 of water.

In order to measure the chemical intensity of the daylight at any time, all that is needed is to expose a strip of standard paper in the pendulum-photometer for a given number of vibrations, and then to find upon the strip, thus exposed, the point at which a shade equal to the standard tint has been produced. Reference to a table give the time of exposure necessary to produce this tint, and the reciprocal of this time represents the intensity of the acting light. If the time necessary were 3 seconds, the chemical intensity would be ⅓; if the time were ½ second, the intensity would be 2. In this way curves of daily chemical intensity were exhibited, which show the variation caused by clouds, or by the changing altitude of the sun. These curves show maxima and minima exactly corresponding to the appearance and disappearance of the sun behind a cloud. The difference between the sun's chemical intensity in summer and winter is thus also clearly depicted.

Based upon the principles of the pendulum-photometer, a much simpler method of making these measurements has been arranged, as follows. A graduated strip made in the pendulum-photometer is fixed in hyposulphite of soda, and pasted upon a board furnished with a scale. The shades of certain points on this fixed strip are compared with the shades on given points upon a graduated strip prepared in the usual way, and not fixed in hyposulphite. The fixed strip is thus calibrated in terms of the unit of measurement, and it may then be used as a means of measuring the chemical action of light. Small pieces of the standard paper are then exposed for a given time to the light which it is desired to measure, until the shade approaches that of a part of the fixed strip. The point of exact coincidence is then read off by the soda flame as usual. In this way a piece of standard paper of 1 square inch of area will serve for 20 separate determinations, and the whole arrangement for exposure may be carried in the pocket. The curve of the chemical intensity of day and sunlight in Manchester, on May 15th, 1863, made with this small instrument, fully bears out the accuracy and ease with which these measurements can be made, and the results of his experiments induced the speaker to express a hope that before long these instruments may be introduced into meteorological observatories.

The determination of the chemical brightness of the various portions of the sun's disc is an interesting application of this new method of photometric measurements.

By help of a camera placed on a 3in. refractor, the speaker allowed the image of the sun—of about 4in. in diameter—to fall upon the standard paper. The sun-picture thus obtained presents interesting features; in the first place, the chemical intensity of the central portions are 3·5 times as great as that of the portions on the limb. A difference of this kind, in the case of the luminous and calorific rays, has already been observed by astronomers, and it is doubtless caused by the absorption effected by the solar atmosphere.

The following results were obtained by measuring the chemical brightness at various points on the sun's disc, on May 9th, 1863; from these numbers it will be seen that the luminous intensity varies very irregularly.

Chemical Brightness of Sun's Disc.

1. At Centre of Sun's Disc.	2. 15° from Edge of Sun's Disc.			3. At the Edge of Sun's Disc.		
	N. Pole.	Equator.	S. Pole.	N. Pole.	Equator.	S. Pole.
No. 1 ....100·0	38·8	48·1	58·1	18·7	30·2	28·2
No. 2 ....100·0	52·8	—	50·6	30·5	—	41·0

Bright patches of considerable area were seen on the picture: these patches, which were not caused by irregularity in the paper or in the lenses, are probably owing to the presence of clouds in the luminous atmosphere of the sun, and they may probably have some intimate connection with the well-known phenomena of the red prominences seen during the solar eclipse.

The speaker concluded by stating that he hoped, with the assistance of his friend Mr. Baxendell, to make a series of regular observations of the variation of the chemical intensities of many points on the sun's surface.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The thirty-third meeting of the British Association for the Advancement of Science will commence in Newcastle-upon-Tyne, on Wednesday, the 26th of August, 1863, under the direction of the following officers:—President: Sir Wm. G. Armstrong, F.R.S. Vice-Presidents: Sir Walter Trevelyan, Bart.; Sir Charles Lyell, LL.D., D.C.L., F.R.S., F.G.S.; Hugh Taylor, Esq.; Isaac Lowthian Bell, Esq.; Nicholas Wood, Esq.; the Rev. Temple Chevallier, B.D., F.R.A.S.: Wm. Fairbairn, Esq., LL.D., F.R.S. General Secretaries: William Hopkins, Esq., M.A., F.R.S., St. Peter's College, Cambridge; John Phillips, Esq., M.A., LL.D., F.R.S., Professor of Geology in the University of Oxford, Museum House, Oxford. Assistant General Secretary: George Griffith, Esq., M.A., Deputy Professor of Experimental Philosophy in the University of Oxford, Jesus College, Oxford. General Treasurer: William Spottiswoode, Esq., M.A., F.R.S., F.G.S., F.R.A.S., &c., 19, Chester-street, Belgrave-square, London, S.W. Local Secretaries for the meeting at Newcastle-upon-Tyne: Capt. Noble, Augustus H. Hunt, Esq., and R. C. Clapham, Esq., 5, Grey-street. Local Treasurer for the meeting at Newcastle-upon-Tyne: Thomas Hodgkin, Esq.

The General Committee will meet on Wednesday, the 26th of August, at one p.m., for the election of sectional officers, and the despatch of business usually brought before that body. On this occasion there will be presented the report of the Council, embodying their proceedings during the past year. The general committee will meet afterwards by adjournment.

The first general meeting will be held on Wednesday, the 26th of August, at eight p.m., when the President will deliver an address; the concluding meeting on Wednesday, the 2nd of September, at three p.m., when the Association will be adjourned to its next place of meeting.

At two evening meetings, which will take place at eight p.m., discourses on certain branches of science will be delivered.

There will also be other evening meetings, at which opportunity will be afforded for general conversation among the members.

The Committees of Sections will meet daily, from Thursday, the 27th of August, to Wednesday, the 2nd of September inclusive, at ten a.m. precisely.

The Section will meet daily, from Thursday, the 27th of August, to Tuesday, the 1st of September inclusive, at eleven a.m. precisely.

The following are the titles of the sections to which communications may be presented:—Section A. Mathematics and Physics. B. Chemistry and Mineralogy, including their applications to Agriculture and the Arts. C. Geology. D. Zoology and Botany, including Physiology, Sub Section D. E. Geography and Ethnology. F. Economic Science and Statistics. G. Mechanical Science.

Notices of communications intended to be read to the Association, accompanied by a statement whether the author will be present or not at the meeting, may be addressed to George Griffith, Esq., M.A., Assistant-General Secretary, Jesus College, Oxford; or to Capt. Noble, Augustus H. Hunt, Esq., and R. C. Clapham, Esq., Newcastle-upon-Tyne.

TRIAL OF STEAM FIRE ENGINES.

We give on the following pages the tables of the performance of steam fire engines, at the public competition which took place in the grounds of the Crystal Palace Company, on the 1st, 2nd, and 3rd ult., under the auspices of the Steam Fire Engine Committee who had provided a fund for the purpose, giving premiums to the exhibitors of such steam fire engines as should, upon trial, prove to be the most efficient for the purposes for which they were constructed. The committee consisted of the following gentlemen, viz.:—Chairman, His Grace the Duke of Sutherland; the Right Hon. the Earl of Caithness; Lord Richard Grosvenor, M.P.; J. G. Appold, Esq.; J. T. Bateman, Esq.; W. M. Browne, Esq.; T. R. Crampton, Esq.; W. M. Crossland, Esq.; W. Fairbairn, Esq.; T. Hawksley, Esq.; J. E. McConnell, Esq.; Henry Maudslay, Esq.; J. Mathews, Esq.; J. Nasmyth, Esq.; J. Penn, Esq.; William Smith, Esq.; and Capt. E. M. Shaw.

The engines were divided into two classes, the large class consisting of those weighing over 30 cwts. and not exceeding 60 cwts., and the small class of those not exceeding 30 cwts. The prizes offered were £250 for the best engine, and £100 for the second best, in each class.

The chief points to which the Committee directed their attention, in addition to the consideration of cost and weight, were those relating to the general efficiency of the machines as fire engines, combining, among other points of excellence, rapidity in raising and generating steam; facility of drawing water; volume thrown; distance to which it can be projected with the least amount of loss, and simplicity, accessibility, and durability of parts.

The descriptions given on the following pages, except the weights, have been furnished by the exhibitors themselves, and are therefore placed in separate tables.

LARGE CLASS.—EXHIBITORS' DESCRIPTION.

Maker.	Weight.	Number and Size of Cylinders. Steam.	Water.	Stroke of Pistons.	Description, Size, and Material of Boiler.	Quantity of Water contained in Boiler when at Work.	Steam Space (cubic contents).	Fire-box Surface.	Tube Surface.	Total Heating Surface.	Mode of Feeding Boiler.	Suction Valves. Size.	Material.	Lift.	Area.	Delivery Valves. Size.	Material.	Lift.	Area.	Size of Suction Pipe.	Size of Ordinary Hose used.
	T. c. q. lbs.																				
Merryweather & Son	2 18 0 8	2 steam $8\frac{5}{8}$	2 water $6\frac{1}{8}$ 4·956 gallons cubic conts.	24in.	Vertical, tubulous circulating shell of homogenous metal, five-sixteenths of an inch thick full, double rivetted; tube and top plates of Lowmoor iron, eleven-sixteenths of an inch thick; stays, bowling iron, 1in. diameter; tubes of solid drawn copper; height, 60in.; diameter, 42in.	30 to 90 gallons	19 to 9 c. ft.	14·5 sq. ft.	192·5 sq. ft.	207 sq. ft.	Injector, main, and feed pumps.	10in. long 1·375 wide	Gun metal, india rubber faced*	1in.	13·75 sq. in.	10in. long 1·25in. wide.	Gun metal india rubber faced‡	1in.	12·5 sq. in.	$5\frac{1}{2}$in.	$2\frac{1}{2}$in. (larger preferred)
Shand & Mason...	2 17 1 0	2 $8\frac{1}{2}$in.	2 7in. 346·356 c. in.	9in.	Vertical, tubular; diameter at fire-box, 45in.; diameter at barrel, 32in.; height, 60in.; iron and brass tubes.	$28\frac{1}{4}$ gallons	7ft. 860in.	$19\frac{3}{4}$ sq. ft.	108 sq. ft. &chambers	$127\frac{1}{4}$ sq. ft.	2 feed pumps and injector.	6in.	India rubber discs	$\frac{3}{4}$in.	12·141 sq. in.	Same	as suction valves		12·141 in.	4in.	$2\frac{1}{2}$in.
Easton & Amos...	2 18 3 12	2 $9\frac{1}{2}$in.	2 small $5\frac{5}{8}$in. 223·65 c. in. and 2 large $6\frac{3}{8}$in. 298.62 c. in.	$8\frac{1}{2}$ to 9in.	Boiler consists of a central furnace, surrounded by a shell of vertical tubes $2\frac{1}{4}$in., around which is a steam chamber or drum, which in ordinary work is filled with water to one-third of its height; from this chamber depends a flat water space or suspended slab, the connexion being made with the steam drum by a series of $2\frac{1}{4}$in. vertical tubes; a series of short $2\frac{1}{4}$in. pass independently of them through the suspended slab and steam drum; a series of $\frac{3}{4}$in. tubes pass from the suspended slab to the water bottom, into which the bottoms of the outer tubes are secured; made of gun metal and steel, in conjunction with best Lowmoor iron.	about 41 gallons	about 11·05 c. in.	37 sq. ft.	173 sq. ft.	210 sq. ft.	By duplicate feed pumps, or direct from large pumps, 1 cock controlling both.	$3\frac{3}{4}$ diam. and $\frac{5}{8}$in. thick	Vulcanised india rubber (flexible)	$\frac{1}{8}$ to $\frac{3}{16}$in.	$3\frac{3}{4}$ to 4in.	Same	as suction valves		...	4in.	$2\frac{1}{2}$in.
Butt and Compy..	2 14 0 4	1 $10\frac{1}{2}$in.	1 6in.	12in.	Upright tubular, with submerged smoke-box, made of iron and steel; diameter, $36\frac{3}{4}$in.; height, 65in.; height of fire-box, 20in.; No. of tubes, 313; diameter outside of tubes, $1\frac{1}{4}$in.; distance between sheets of submerged smoke-box, $4\frac{3}{4}$in.; length of submerged smoke-pipe, 16in.	about 62 gallons	$8\frac{1}{2}$ c. ft.	$16\frac{1}{2}$ sq. ft.	$183\frac{1}{4}$ sq. ft.	200 sq. ft. nearly	2 plunger pumps, 1 by 12, worked direct.	$4\frac{1}{2}$in.	Rubber discs on central stem (four such at each end)	$\frac{1}{4}$in.	equal to area of pump	Same	as suction valves		...	$4\frac{1}{2}$in.	$2\frac{1}{2}$in.
Mr. Roberts	1 19 1 4	1 7in.	1 $9\frac{1}{2}$in. 414·54 c. in. allowance made for guide fork 28·46 c. in.	1 steam 13in. 2 water each $3\frac{1}{8}$in.	Body of boiler, 30in. diameter and 24in. deep, made of best treble refined iron, full five-sixteenths of an inch thick; tube plates bare $\frac{1}{2}$in. thick; the tubes are 248 in number, $\frac{3}{4}$in. inside, secured at both ends into tube plate; boiler is fitted with two safety valves, glass guage and three guage cocks, injection and pump.	$12\frac{1}{2}$ gallons	6597 in.	23 sq. ft.	118 sq. ft.	141 sq. ft.	The injector is used for feeding, and provision is also made for a pump.	$7\frac{3}{4}$in.	Vulcanised india rubber discs $\frac{5}{8}$in., thick	$\frac{1}{2}$in.	12·17 in.	Same	as suction valves		12.5 in.	4in.	$2\frac{1}{2}$in.
Nichols .... (Manhattan)	2 10 1 4	1 9in.	1 rotary 12 & 9in. breadth 7in.	$8\frac{1}{2}$in.	Lee & Larned's annular, made of iron, brass, and steel; diameter, 36in.; height, 65in.; height of fire-box, 28 in.; 243 tubes, from 47 to 3in. long, and $2\frac{3}{4}$in. and $1\frac{3}{4}$in. in diameter.	about 38 gallons	$7\frac{1}{4}$ c. ft.	48·5 sq. ft.	133·5 sq. ft.	In contact with water $149\frac{3}{5}$ sq. ft.; with water and steam 182 sq. ft.	Direct acting independent feed pump.	...	...†	$1\frac{1}{2}$in.	10.5 in.	...	...	$1\frac{1}{2}$in	10·5 in.	4in.	$2\frac{1}{2}$in.
Gray & Son.........	1 18 1 4	1 $9\frac{1}{8}$in.	1 7in. 307·87 c. in.	8in.	Boiler is a cylinder 28in. in diameter and 26in. long, slowly revolving over fire-grate on two trunnions fixed at its ends, and contains 28 iron tubes, 2in. external diameter, and 28 iron tubes $1\frac{1}{2}$in. diameter; shell of boiler is of steel plates, $\frac{1}{4}$in. thick, and ends of ditto $\frac{1}{2}$in. Lowmoor iron; boiler is enclosed in iron casing, lined with fireclay.	about $17\frac{1}{2}$ gallons	3·855 c. ft.	smoke box 2·93 sq. ft.	53·45 sq. ft. 18.81 direct heating surface	75·19 sq. ft.	By pump worked by engine and by hand when engine is not at work.	$6\frac{1}{2}$in.	Junction rubber on metalic grate surface	1in.	29·46 sq. in.	$5\frac{1}{2}$in.	...	1in.	23·75 sq. in.	1in.	4in.

* Gun metal-faced valves are fitted, and can be used if preferred. † Gunmetal-faced valves are fitted, and can be used if preferred. ‡ Rotary pump with reciprocating brass valves or pistons.

LARGE CLASS.

FIRST TRIAL.

Delivering 1000 gallons into a tank at a true distance of 67ft., and 27° from the horizon. Depth from which water was drawn, 4ft. 6in. The water in the boiler being cold when the signal was given to commence, each engine commencing to work on attaining steam pressure of 100lb. to the square inch.

No.	NAME.	Time of raising Steam to 100lbs.	Time of filling Tank.	Total Time.	Remarks.
		′ ″	′ ″	′ ″	
1	Easton & Amos ...	13 14	6 16	19 30	
2	Merryweather & Son	10 25	9 42	20 7	Began to work at 100lbs., fell directly to 40lbs., and continued so throughout; stopped and steam rose to 130lbs.
3	Shand & Mason...	10 51	12 19	23 10	Suction pipe choked; left off working about 2 minutes.
4	Butt & Co.	16 30	6 48	23 18	
5	Roberts	11 40	20 24	32 4	

SECOND TRIAL.

Delivering 1000 gallons into tank at same distance commencing with full steam.

No.	NAME.	Steam at Begining.	Steam during Work.	Time of filling Tank.	Remarks.
				′ ″	
1	Shand & Mason...	100		3 0	
2	Butt & Co.	100		3 3	
3	Merryweather & Son	115		3 7	
4	Roberts	80		12 30	Not filled.
5	Easton & Amos...				

THIRD TRIAL.

Delivering into Large Tank.

Name.	No.	Time.	No. of Deliveries Open.	Length of Hose.	Size of Nozzle.	Depth from which Water was Drawn.	Horizontal Distance in Feet.	Vertical Height in Feet.	True Distance in Feet.	Angle from Horizon.	Average Steam Pressure.	Average Water Pressure.	No. of Gallons Delivered.	Time of Raising Steam.	Remarks.
		hr. min. sec.				ft. in.									
Merryweather & Son	1	1 24 55	2	440	1¼	16·4	40	40	56	45°	91	89	16·086	10′ 32″ to 80lbs	Fire lighted at 4h. 1m. 55s.; guage moved at 4h. 8m. 20s.; engine started at 4h. 12m. 27s.; water drawn in about 10 revolutions; pumps not primed, va[illegible] box leaked slightly, and engine worked satisfactorily in every respect.
Shand & Mason ...	2	2 0 0	2	440	1¼ & 1⅜	16·4	40	40	56	45°	96	62	12·917	11′ 21″ to 120lbs	Fire lighted at 11h. 25m. 40m.; guage moved at 11h. 32m. 6[illegible].; engine started at 11h. 37m. 7s.; pumps primed at 11h. 45m. [illegible]s.; drew water at 11h. 47m. water first through nozzle at 11h [illegible] in hood at 11h. 49m. 18s., shifted nozzle (3¾m. delay); high wind.
Roberts	3	2 0 0	1	420	1¼	16·4	40	40	56	45	75	75	9·936	11 20 to 80lbs	Fire lighted at 11h. 17m.; engine started at 11h. 28m. [illegible]s.
Butt & Co.	4	0 46 50	2	440	1¼	16·4	40	40	56	45°	78	78	8·280	14′ 10 to 45lbs	Fire lighted at 5h. 55m. 10s.; started engine at 6h. 9m. 20s., repeatedly stopped from slide valves not acting, and stopped entirely at [illegible], from cylinder cover breaking.
Easton & Amos ...	5	1 32 35	2	440	1¼	16·4	40	40	56	45	98	41	[illegible]	12 30 to 90lbs	Fire lighted at 2h [illegible]; guage [illegible] 2h. 10m., started [illegible] at 2h [illegible]; pumps primed, worked till 2h. 54m. [illegible] stopped to shift plungers, went to work again, and stopped entirely at [illegible] 10s., from two [illegible] falling out
Nicol (Manhattan)	6	0 4 55	2	420	1¼	16·4	40	40	56	45°	—	—	None.	[illegible] to [illegible]lbs	Fire lighted at 10h 51m. 16s.; guage moved at 10h. [illegible]m 2[illegible]s.; drew water directly; steam up to [illegible]lbs at 11h [illegible]m [illegible]s.; stopped two minutes, started again, made a few revolutions, and fly wheel broke.

FOURTH TRIAL.

Vertical Jet against T[illegible]wer.

No.	NAME.	S[illegible] of Jet.	Greatest Height Thrown.
			Feet.
1	Shand & Mason	[illegible]	1[illegible]
2	Merryweather & [illegible]n	[illegible]	1[illegible]
3	Roberts	[illegible]	1[illegible]
4	Lee & Co	[illegible]	65

Gray's Engine lighted fire at 7h. 7m. 40s.; steam 90lbs. at 7h. 17m. 0s.; got to work at 7h. 23m. [illegible] to blow fires, at 7h. 27m. [illegible] water through [illegible] connected with the steam guage breaking [illegible] experiment [illegible]

SMALL CLASS.—EXHIBITORS' DESCRIPTION.

Maker.	Weight.	Number and Size of Cylinders. Steam.	Number and Size of Cylinders. Water.	Stroke of Piston.	Description, Size, and Material of Boiler.	Quantity of water contained in Boiler when at work.	Steam Space (cubic) contents.	Fire-box Surface.	Tube Surface.	Total heating Surface	Mode of Feeding Boiler.	Suction Valves. Size.	Suction Valves. Material.	Suction Valves. Lift.	Suction Valves. Area.	Delivery Valves. Size.	Delivery Valves. Material.	Delivery Valves. Lift.	Delivery Valves. Area.	Size of Suction pipe.	Size of ordinary Hose used.
	T. c. q. lbs.																				
Shand & Mason	1 9 2 0	1 7in.	1 9in.	8in.	Vertical, tubular; diameter at fire-box, 2ft. 10in.; ditto at barrel, 2ft. 1in.; height, 4ft. 6in.; Iron with brass tubes.	16½ gallons	3ft. 1068in.	14½ sq. feet	48 sq. fec.	62½ sq. feet	1 feed-pump and injector	2¾in.	India rubber discs (7)	⅜ lift	21 sq. in.	Same as suction valves but 6 in number only			18in.	4½in.	2¾in.
Lee & Co	1 10 0 0	1 7¼in.	1 4¼in.	9½in.	Upright, tubular; with submerged smoke-box; iron material; diameter, 27in.; height, 60in.; tubes, 1¾in. diameter outside; 199 in number.	about 26 gallons	4·32 c. feet	9½ sq. feet	97¼ sq. feet	106 feet (nearly)	1 plunge pump 1in. by 12in. worked direct	4 at each end 3½in. diam.	Rubber discs on central stem covering opening in valve seat 4 at each end	½in.	equal to area of pump	Same as suction valves				4in.	2¾in.
Merryweather & Sons.	1 10 1 12	1 6½in.	1 4¾in., 1·46 gallons.	12in.	Vertical, tubulous, circulating; height, 48in.; diameter, 28in; shell of homogenous metal full ¼in. thick; tube and top plates, Lowmoor iron, nine-sixteenths of an inch thick; tubes of solid drawn homogenous metal.	from 15 to 30 gallons	about 4 c. ft.	7·5 sq. feet, including flue surface	57 sq. feet	64·5 sq. feet	By injector, main pump, and feed pump	9·5in. long, 1·0625in wide	Gun metal leather faced (india rubber can be used if preferred)	1in.	10 sq. in.	9·5in. long, 1in. wide	Gun metal leather faced (india rubber can be used if preferred)	1in. bare	9·5 sq. in.	3½in.	2½in.

SMALL CLASS.

First Trial.

Delivering 1000 gallons into a tank at a true distance of 50ft. and 37° from the horizon. Depth from which water was drawn, 4ft. 6in. The water in the boilers being cold when the signal was given to commence, each engine commencing to work on attaining steam pressure of 100lb. to the square inch.

No.	Name.	Time of raising Steam to 100lbs.	Time of filling Tank.	Total Time.	Remarks.
		′ ″	′ ″	′ ″	
1	Shand & Mason...	11 36	5 24	17 0	Owing to a broken bolt, there was great leakage in water cylinder.
2	Lee & Co............	11 55	6 3	17 58	
3	Merryweather & Son	12 15	9 14	21 29	

Second Trial.

Delivering 1000 gallons into tank at same distance, commencing with full steam.

No.	Name.	Steam at Beginning	Steam during Work.	Time filling Tank.	Remarks.
				′ ″	
1	Shand & Mason...	85	—	5 49	
2	Lee & Co:..........	125	—	5 50	Leakage remedied.
3	Merryweather & Son	100	—	6 17	

Third Trial.

Delivering into Large Tank, commencing with Full Steam.

Name.	No.	Time.	Number of Deliveries open.	Length of Hose.	Size of Nozzle.	Depth from which Water was Drawn.	Horizontal Distance in Feet.	Vertical Height in Feet.	True Distance in Feet.	Angle from Horizon.	Average Steam Pressure.	Average Water Pressure.	No. of Gallons Delivered.	Remarks.
		Hr. Min. Sec.			in.	ft.								
Shand & Mason ...	1	1 0 0	1	420	1 & 1¼	16·4	40	40	56	45°	146	80	8142	Steam ready at 150 lbs.; started at 7h. 3m. 32s.; stopped at 7h. 12m. 5s. to put on an additional length of hose; worked well throughout.
Merryweather & Son	2	1 0 0	1	420	⅞	16·4	40	40	56	45°	86	45	4885	Steam ready at 110 lbs.; commenced work at 3h. 43m. 30s.; pumps primed.
Lee & Co.	3	1 0 0	1	420	¾	16·4	40	40	56	45°	80	60	4278	Steam ready, started at 2h. 1m. 0s.; worked well, without any stoppage.

AWARDS.

At a meeting of the Committee held on the 8th July, 1863, his Grace the Duke of Sutherland in the Chair, the following prizes were awarded:—

LARGE CLASS.

Messrs. Merryweather & Sons, 1st Prize, £250.
Messrs. Shand & Mason ....2nd Prize, £100.
Mr. W. Roberts, highly commended.

SMALL CLASS.

Messrs. Shand & Mason ....1st Prize, £250.
Messrs. W. Lee & Co. ....2nd Prize, £100.

(Signed) On behalf of the Committee,

SUTHERLAND, Chairman.
E. M. SHAW, Hon. Sec.

IRON FLOATING DOCK, SOURABAYA, JAVA.

In THE ARTIZAN of February last we gave a short account of the successful launching of an iron floating dock at Sourabaya, Java. We regret, however, to learn since our first notice that, in an engineering and commercial point of view, the undertaking has resulted in a decided failure. The dock is, it appears, now entirely under water. It was put together at Grissee, on the coast of Java, about nine miles from Sourabaya, and was launched in the novel manner described in our February number, viz., by letting the water to it, and then towing it away. The dock floated then fairly enough, drawing, with engines and appurtenances, about two feet of water. Without testing the capabilities of the dock or the machinery in any way, it was brought into six fathoms water, anchored, and sunk to receive a small steamer, the *Prince of Orange*. But now came the real test; the dock sunk, not slowly but surely, going down with great rapidity, one end about eight feet lower than the other. So violent, indeed, was the descent that the *Prince of Orange*, which was waiting just outside, was drawn into the vortex, shooting into the dock like an arrow, fortunately without sustaining any damage. The parties in charge endeavoured to set the pumps (which are on the centrifugal principle) to work, but as the engines, which were intended to run at 60 revolutions, could only be got to work up to 30, the pumps would not draw at all. The dock meanwhile continued to sink until the engine fires were extinguished. A small portable engine and pump were hastily brought and set to work, but without effect. To make bad worse, the anchorage proved insufficient, and the dock swung round on the sloping muddy bank on which it had sunk, with every change of tide, and thus worked itself deeper and deeper still in the mud, in which it now lies imbedded about eight feet deep. Endeavours have been made without ceasing to get it up again, but without success. In these attempts considerable damage has been done to the dock, several large holes having been torn in the plating by the injudicious mode of attaching the chains employed, and competent authorities on the spot are of opinion that the dock will never be brought up again. It would be difficult to say exactly what is the real cause of the disaster.

The unfortunate shareholders who have lost their property make comparisons with a similar dock that is being built for the Dutch Government for Batavia. We find that it exceeds the dock at Sourabaya in weight of material about 50 per cent. That the Sourabaya dock was also very badly put together seems to us beyond doubt; the bottom was the only part at all well done, which accounts for the dock making little water while floating about two feet deep; but in the sides, rivets that could, we understand, be shaken by the fingers, might be counted by hundreds, and gaping seams filled with wooden wedges were plentiful.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents

To the Editor of THE ARTIZAN.

SIR,—It is sometimes desirable to transmit a motion or power from the place where it is generated to a distant one, and having to do so now, I should be obliged to your inviting a discussion of the subject, as follows:—

A water power is at the distance of 600 yards from the mill, with no means of bringing it nearer. It is proposed to erect a turbine of the effective force of 100 horses, which will drive a drum or rigger of 12 feet in diameter, carrying a wire rope sustained at certain distances to a drum or rigger at the mill. It is proposed that the speed of the rope shall be about 30 feet per second: therefore, the constant strain on it will be about 1800 pounds.

The following are desiderata:—Which would be better, a steel or iron rope? Its diameter, and weight per yard, and size of wire? Should it be kept greased or dry? What would be its probable duration? What would be the probable proportions of power absorbed by this method of transmission? What better or less costly method can be devised?—I am, Sir, yours obediently, G.

To the Editor of THE ARTIZAN.

SIR,—In your Journal for July, 1863, at page 150, is an article on "The Manufacture of Duplicate Machines," by Mr. John Fernie, Assoc. Inst., C.E., in which the writer appears to think that "until lately, little or nothing had been done in its application to the manufacture of machines or engines on a large scale," "until within the last five years, with the sanction of Mr. Kirtley, the Locomotive Superintendent, he had established the system in the workshops of the Midland Railway, at Derby, which has proved most beneficial, not only in reducing the cost of the work, but in greatly improving it."

Now although Mr. Fernie may not be aware of the circumstance, it is nevertheless a fact, that the late firm of Sharp, Roberts and Co., made ten engines for the Grand Junction Railway Company, before the opening of that line, about 25 years ago, all the parts of which were duplicates of each other, in confirmation of which I would refer Mr. Fernie to the then Locomotive Superintendent, Mr. Thomas Melling, Rain Hill Iron Works, who frequently sent to Sharp, Roberts and Co. for parts of engines out of their stock, and always had the satisfaction to find they fitted in every respect; so completely was the system carried out that every part of the boiler, the fire-box, and smoke-box would interchange. It is well known that the same firm (Sharp, Roberts and Co.) made all their smaller machines in duplicate, and provided for the users of the "self-acting mule" a book of plates, showing all the parts of the headstock, with the name and number of each, to enable parties to order duplicates for repairs.

RICHARD ROBERTS, C.E.

BOOKS RECEIVED.—*On the Bhore Ghaut Incline of the Great Indian Peninsula Railway.* Reprint of a paper read at the Bombay Mechanics' Institute, by the late J. J. Berkley, Esq., M.I.C.E., F.G.S., with an Appendix by A. A. West, C.E. Bombay: The Education Society's Press, Byculla, 1863.——*Portefeuille des Machines, de l'outillage et du Matériel relatifs à la construction, &c.*; Dirigé par. C. A. Oppermann, Ingénieur, Constructeur. Paris: Dunod, 19, Quai, des Augustins.

NOTICES TO CORRESPONDENTS.

J. A. G.—Received and inserted. We shall be glad to hear from you from time to time. The Journal has been sent to you.

W. J. C.—Want of space prevents our giving insertion to the plan this month, but will give it in our next; meantime, you may send us further details.

EISEN.—The results of Mr. D. Kirkaldy's Experiments on Wrought Iron and Steel, the subject to which you refer, was discussed some time since at a meeting of the "Institution of Engineers in Scotland," when Dr. Macquorn Rankine, referring to his remarks upon these experiments at the last meeting, and to the experiments he had himself made upon the fracture of railway axles, exhibited and explained drawings of some of the fractures. There were nine examples, and they might be taken as a fair representation of the character of the other examples. The first five had broken spontaneously, and it was evident from the appearance presented that the iron had invariably been of a fibrous character, excepting a few small crystals about the size of pins' heads. The other four had been broken by the hammer, and were all axles that had only run a short time. Some of these were fibrous, and some of them were crystalline, showing that the same iron would exhibit a fibrous or a crystalline character, according to the manner in which it was broken. The accompanying woodcuts (Figs. 1 and 2) were longitudinal sections of axles, showing different positions of the fibres near the surface. In Fig. 1 the journal had been produced wholly by turning, and the fibres were consequently interrupted: hence there was a tendency for a crack to begin at the shoulder. In Fig. 2 the journal, before being turned, had been forged down nearly to the proper diameter, the fibres were continuous, and there was no tendency to break in the manner before referred to. At the same meeting Mr. Gray exhibited a drawing (shown in the woodcut Fig. 3) of the mandril of a calico-printing machine, and stated that the fracture always took place at the shoulder of the axles where it was 3⅞ths in diameter. The length of the journal was 7in., and the fracture always took place at the outer diameter of the fillet. With reference to your other queries, we are glad to be able to inform you that Mr. Kirkaldy has published a Second Edition of his "Results of an experimental enquiry into the tensile strength and other properties of Wrought Iron and Steel," from a perusal of which we feel assured you will be enabled to arrive at a satisfactory solution of the questions involved. Your bookseller at Leipsig will be able to obtain the work for you.

FIG. 1.

FIG. 2.

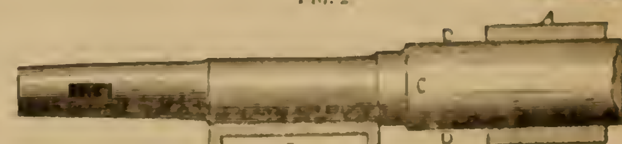


FIG. 3.

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Saxby *v.* Stevens.—This was an action tried in the Court of Queen's Bench on the 8th ult., before Lord Chief Justice Cockburn and a special jury, for the infringement of a patent for the simultaneous working of the points and signals for the prevention of accidents. The question was of a very complicated character, and was expected to have occupied the court the remainder of the sittings, but at twelve o'clock, when the learned counsel for the plaintiff got about half way through his opening statement, the Lord Chief Justice interposed, observing that if ever there was a case that ought to be sent before an arbitrator, instead of being tried by a judge and jury, this was the case. Upon that the learned counsel conferred together and settled the terms of a reference, and a verdict was taken for the plaintiff, subject to that arbitration.

Southwood *v.* Fairbairn.—The plaintiff is an engineer now living at Birmingham, but has spent many years in the Australian diggings. On his return home he took out a patent for crushing quartz and all descriptions of ore and stones, not only for extracting gold, but for the purpose of metalling roads. In November he entered into a contract with the defendant, an engineer in Southwark, to make and erect on the defendant's premises, and work with 10 or 12-horse power, and make ready for experiments, one of those machines within two months for £95, £40 to be paid during or on the completion of the machine. A dispute subsequently arose, and the defendant refused to complete the contract, although the plaintiff had paid him £20 on account. This refusal the defendant did not now attempt to justify, and paid £40 into court; therefore, the only question was the amount of damages to which the plaintiff was entitled. The plaintiff claimed as damages his inability to exhibit the machine or to execute various contingent orders which would each have realised a profit, or to carry out arrangements he had made for going out to Australia to push the patent under the auspices of a company. The defendant contended that such damages were rather conjectural than substantial. The learned Baron said the difficulty was to lay any fixed rule as to what were direct and proximate damages, and that it was one of those matters which lawyers, when puzzled, put upon the jury, but that annoyance or vexation arising from unpunctuality was not a subject for damage. The jury found a verdict for £30 more than the sum paid into Court.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

New Method of Raising a Steamer.—M. Bauer, an engineer, has, after long preparatory labours, succeeded in raising the Bavarian steamer *Ludwig*, which sank two years ago in the Lake of Constance, in consequence of coming into collision with a Swiss steamer. The engineer, in order to raise the vessel, which was lying at a depth of 70ft., made use of an apparatus of his own invention. By means of divers he attached to her, one on each side, two large balloons made of water proof linen, which he filled with air. When the expansion had become sufficient, a movement was observed in the water, which look as if boiling, and the vessel gradually came to the surface.

Metropolitan Zinc Rolling Company.—A prospectus has been issued of the Metropolitan Zinc Rolling Company, with a capital of £100,000 (of which one-half is to be first put forth), in shares of £10. The object is to establish in London, upon an efficient scale, rolling works for the production of sheet zinc and copper, the demand for which is steadily increasing. Arrangements have been made for the rental of premises adjoining the City-road basin and also for the purchase of the whole of the machinery of the Mines Royal Copper Company.

Cost of London Streets.—New Oxford-street and Cranbourne-street, constructed between 1841 and 1847 by the Commissioners of Woods and Forests from the London Bridge Approaches Fund, cost—the former, £330,074, and the latter, £206,093. Victoria-street, Westminster, constructed between 1845 and 1851 by the Westminster Improvement Commissioners, from the Coal Duties and improved rates, and by money raised on mortgage, cost £215,000.

Our Shipping.—At the close of the year 1862 there belonged to the ports of the United Kingdom 28,440 vessels of 4,934,400 tons, usually navigated by 228,139 men and boys—an increase in the course of the year of 402 vessels, 127,574 tons, and 3315 men and boys. The vessels belonging to the British plantations were 10,967, of 1,107,696 tons, and manned by 75,934 persons.

Paper Material.—In searching for fibre suited for the manufacture of paper, the following hints may be found useful to residents in tropical and other regions. Any fibre capable of cohesion when precipitated on a draining surface from mechanical suspension in water, after having been reduced to a pure state of capillary subdivision by mechanical action, is fit for the manufacture of paper. For all practical purposes it may be accepted as a rule, that for the manufacture of white paper all fibres require bleaching. Raw fibre may be divided into four classes:—1. That which is easily reduced and easily bleached. 2. That which is easily reduced, but difficult to bleach. 3. That which is difficult to reduce, but easily bleached. 4. That wherein perfect bleaching involves the integrity of the fibre. The most profitable shape in which to send fibre to the English market is that of half-stuff (or pulp). Well prepared bleached half-stuff would fetch £25 per ton in the market. The best machine for reducing fibre to half-stuff is the ordinary rag-engine, costing about £150, carrying about 2cwt. of stuff, and requiring a maximum of seven-horse power for driving. The half stuff would require to be pressed, dried, and packed in bales. For experimental purposes in reducing the fibre, anything smaller than the ordinary sized rag engine is useless, as the weight of the triturating roll—about 15 cwt.—cannot be dispensed with, so that laboratory experiments are necessarily confined to rough separation and bleaching. Moreover, laboratory experiments, unless conducted with the utmost care and skill, furnish no reliable data for commercial operations. As a preliminary, the character of the fibre ought to be determined in the laboratory:—1st. In relation to its structure, having in view ease in fibrous separation. 2nd. In relation to its chemical construction, having in view ease in bleaching. Bleached half-stuff would realise a larger profit than unbleached, always supposing that the process of bleaching, owing to the accident of geographical position or otherwise, did not entail expenses extra to that properly belonging to the operation under the most favourable circumstances. Fibre could be sent into the market as half-stuff unbleached whenever its characteristics were reliably established.

Discovery of Naturally-formed Carbonate of Soda.—Dr. Haines, of Grant College, Bombay, describes the occurrence in vast quantities of naturally-formed carbonate of soda in the neighbourhood of Aden. The substance as found contains 50 per cent. of natural carbonate, and occurs along the coast, for ten miles at least to the east of Aden, in hollows behind high-water mark, to which the sea has access by percolation. Its formation is attributed to the percolation of the sea-water through the fragments, and pebbles of limestone constituting the shingle of the shore, probably by the partial interchange of elements between the salt or chloride of sodium and the carbonate of lime giving rise to the production of chloride of calcium and carbonate of soda. It is surmised that the formation of carbonate of soda may go on along the whole thousand miles of the south-east Arabian coast.

Lamp for burning Coal Oil.—Mr. N. B. Vidal, of Philadelphia, U.S., has brought forward an improved coal oil lamp, the wick tube of which, above the base of the burner, assumes a fan shape, so that as the wick is raised the upper edge of the same is spread out to nearly double its former width. By this method the oil carried up by the wick is distributed over so extended a surface that it is entirely consumed, and no portion can remain to clog the wick, or run down the outside of the tube, to be evaporated and discharged into the air of the room, as is the case where a large supply of oil is constantly brought to a small burning surface. No chimney is needed with this lamp, which burns without smoke, and with a clear flame.

The Goodwin Sands.—A public company is being formed for the embankment and reclamation of the Goodwin Sands, and to convert these sands into an island, whereon to build a new township, fortifications, docks, wharves, &c.; also to reclaim the land for agricultural purposes, &c. By the accumulation of the sand from the north, the gulf stream has been shifted to the southward, the great increase of the sand coming from the north having formed a shoal, called the fork, opposite Trinity Bay. By the proposed embankment, the whole of the Channel, between the Goodwins and the Break, will become entirely clear. The company contemplated taking a grant of the Goodwin Sands for the objects they have in view, to recover the sunken ships and treasures, which it is thought will pay all expenses. The land to be reclaimed will consist of about 20,000 acres. The first work to be accomplished is the entrance of the intended lock, which will be made by caisson gates. This lock will be of sufficient capacity to admit the largest class of vessels, being 860 feet long, 100 feet wide, and 40 feet water at the lowest ebb from the sill, adjoining which will be the tidal dock, containing 287 acres, with 40 feet water. When that is completed the embankment will be commenced, as well as the docks, which are to cover about 626 acres. In case of stress of weather, ships in the Downs are to take refuge on payment of a small tonnage. Capacious docks are intended to adjoin, for repairing or examining ships of any class without unloading.

Iron Shipbuilding on the Tyne.—Messrs, T. M. Smith, builders, at North Shields, are rapidly completing one of the first iron sailing ships built on the Tyne. She will be full rigged, will be 1116 tons burthen, and is intended for the cotton trade. Her dimensions are 202ft. long between perpendiculars; extreme breadth 34ft.; depth of hold 23ft. This firm is also about to commence to build an iron East Indiaman to be added to their Calcutta line. She will be 1200 tons, 190ft. long, 37ft. 6in. beam, and 22ft. depth of hold.

Materials used in the 1862 Exhibition Building.—Bricks, 17,250,000; lime, 5611 cubic yards; sand, 18,352 cubic yards; ballast, 8632 cubic yards; cement and plaster, 47,105 bushels; cast iron, 4953 tons; wrought iron, 2269 tons; timber, 439,178 cubic feet; 2,238,722 lineal feet 9in. by 3in. battens, deals, and planks; stone, 62,831 superficial feet, 6in. thick and under; ditto, 6877 cubic feet; zinc, 225,861 superficial feet; lead, 74 tons 14 cwt.; felt, 623,000 superficial feet; slating, 71,260 superficial feet; glass, 216,808 panes, containing 667,542 superficial feet; putty, 95 tons 16 cwt; nails, 193 tons 12 cwt.; cash paid in labour, £138,348.

Iron Ships—Prevention of Fouling.—The iron clipper ship *Chili*, which was coated with Messrs. Peacock and Buchan's composition, for the prevention of fouling, has recently returned from New Zealand, having been twelve months out of dock, and upon her being examined in Mr. Lungley's dock, her bottom was found to be perfectly clean. It is stated that there is not a particle of copper in this composition.

Boiler Riveting in the United States, by W. H. King, U.S.N.—In the United States there are three mechanical modes of uniting plates together; namely, machine-riveted by the two first-named methods, in both of which the rivets are put in hot. West of the Alleghanies, all riveting is done by hand, and at Pittsburgh, Louisville, and other places, the rivets are driven cold in all places accessible for the purpose. For the cold process, a superiority is claimed consequent upon the holes being well filled with the body of the rivets; that is, there is no contraction—hence reduction in the strength and in the rivets' diameters after the workmen cease hammering on the heads. The reverse must be the case when driven hot; for, in cooling, the diameters are reduced by contraction. Moreover, none but the best quality of iron can be used in rivets driven cold; because, if the iron be inferior, it is sure to crack or split through the head, each one being tested by the heading. For hot riveting, it is claimed that, in cooling, the rivets contract in length, drawing the sheets more closely together, thereby creating adhesion sufficient to add to the strength of the joint. Mr. Clarke, resident engineer of the Britannia-bridge, made some experiments to determine the value of this. Three plates were riveted together by a machine, maintaining a temperature of 900 degrees in the rivets; each outside plate had a circular hole in which the rivets fitted exactly; but in the centre one the hole

was oval, or $2\frac{1}{2}$ in. long for a $\frac{7}{8}$ rivet, and the rivet was not allowed to touch either end of this hole. A strain was then put on the centre plate till it began to slide, which it did abruptly. Several trials were made, and the least result was an adhesion equal to $4\frac{1}{2}$ tons with $\frac{7}{8}$ rivets. Mr. Clarke infers from this experiment that, by judicious riveting, the adhesion may in many cases be nearly sufficient to counterbalance the weakening of the plates from punching the holes. In this particular we regard his opinion as an error; for if he had continued the strain on the plate until it parted, or the rivets broke, he would doubtless have found that the total pressure, or breaking-strain, would have been 56 per cent. if single-riveted, and 75 per cent. if double-riveted, of the sheet, as fully tested by other experiments. Theoretically, there is a gain from adhesion in hot-riveted joints, but practically this seems to be lost by the contraction of the rivets' diameter, thus making the total or breaking pressure the same. In western river boilers, where the pressure of steam used is higher than in any other part of the world, no difficulty has ever been experienced from the cold riveted joints not being closely united and perfected tight; and as regards strength compared with the hot-riveted, superiority is claimed by those having cold-riveted boilers in charge. In either mode of hand-riveting the rivets can be seriously injured by too much hammering, and in any case by overheating. Due regard should be had to the temperature, and the blows of the hammer should be hard and quick, and not continued longer than necessary to form the head. Machine riveting has the advantage of forming the head at a single blow, and the rapidity with which the work can be performed must always give it preference over all other methods where it can be employed. It is to be regretted that no extended set of experiments have ever been made in this country to determine the relative strengths of the different modes of riveting and uniting the sheets of steam boilers and other iron structures; also to test the relative value of materials used in this country at the present day; for it must be evident that although the results of the European experiments on iron and steel are of value to us, yet they cannot be regarded as entirely applicable to American constructions, because our iron ores, the temperature of blast of smelting furnaces, and manner of working the metal through the different processes, and the fuel used, all differ in a large degree from those abroad.

MAGNETO-ELECTRIC MACHINES.—The following is extracted from a French scientific paper:—One of the principal obstacles encountered in the practical application of electricity as a motive power, is found in the small amplitude of the elementary movements of electro-magnets, since their powers of attraction do not commence till they are almost in contact—the limit of distance varying from 1 to 2 millimetres at most. Thus, all inventors who have proposed their use as a means of producing motive power, have sought to overcome the difficulty by causing the attraction to exert its powers at an angle, or by following the surface of a cone so as to augment the amplitude of the movements, with, however, a proportionate decrease of power. We now propose the adoption to be called *contracteur electrique*, which shall imitate the play of the muscles in the organized body, and which will permit the transformation of the trifling direct motion of a series of electro-magnets, into a movement, ten, twenty, or a hundred times as great. It we take discs of soft iron, and convert them into very deeply-grooved pulleys, in order that they may receive some thousands of turns of insulated copper wire, we can thus transform them into magnets, by the passage of an electric current through the wire. If we superimpose a number of these discs, separated by small rings of india rubber, one millimetre thick, on the passage of a current, all the discs will approach each other, compressing the india rubber; and thus the pile of discs, if composed of 200 elements, for example, will shorten or contract on itself one decimetre, although each disc moves through but one half millimetre. This is the first idea of contractors or electric muscles. It is easy to understand that by fitting one end of such a pile to the connecting rod and crank of a fly-wheel, and the other extremity to a fixed support, we can obtain as great a number of revolutions as we desire, with a force depending on the power of the pile. By combining this idea with that of tubular electrical piles producing electricity in quantity, shall we not find the solution of the problem of applying electricity to the economical production of motive power?

PROTECTION OF IRON HULLS.—The following was found to be the result on scraping down the sides and bottom of the iron screw steam storeship *Industry*, in dock at Woolwich. The *Industry* had been coated on the port side with a composition produced in the dockyard, on the starboard side with Peacock's composition, and in the hold with Day's marine cement for resisting the influence of moisture, and the effects of bilge water on the rivets. Day's cement has been pronounced superior to anything yet tested for the purpose. It adheres so well that its removal can only be accomplished by means of hammer and chisel. Peacock's composition is also reported to be highly effective.

CHANGE IN MEASURES FOR COALS.—As great inconvenience has long been felt at the measures for coals, a movement has been inaugurated among the principal merchants, shipowners, and others engaged in the trade, for the purpose of abolishing the measure per "keel," and substituting that of per "ton." The parties interested have signed the following document in reference to the subject:—"We, the undersigned merchants, shipbrokers, and shipowners of Newcastle-upon-Tyne, recognising that the keel has long been obsolete, and does not now in reality exist as a standard measure; that it bears no relation to foreign weights and measures, but is one that is most difficult and tedious to establish (the reduction having first to be made in tons and hundredweights, and subsequently into keels); and furthermore, that coals and coke are now sold by the ton, and not by keels and chaldrons, hereby pledge ourselves, and agree to commence at an early date, to conduct all our chartering operations, whenever and for wherever practicable, on the basis of the established and legitimate weight of the realm, by the ton, in order to simplify calculations which, as hitherto conducted, cannot have failed to be a source of great inconvenience to foreigners having business with this port. Newcastle-upon-Tyne, July 6, 1863." The document is signed by the largest mercantile and shipping firms in Newcastle, as well as by several of the colliery owners.

STEAM PLOUGHS IN ANTIGUA.—The two steam ploughs (Fowler's and Savory's patents) recently introduced were doing their work well. They were found to be of the utmost service on heavy soils, many fields that had been lying almost useless for upwards of 20 years being now upturned and pulverised.

LUMLEY'S RUDDER.—Since the *Columbine* left Sheerness, on particular service, Lumley's new patent rudder, with which the vessel is fitted, has been thoroughly tested at sea, and is declared by the authorities to be a complete success, at least 50 per cent. being gained over the old rudder, both in time of turning and in the diameter of the circle.

NAVAL ENGINEERING.

THE LORDS OF THE ADMIRALTY have abandoned the intention—at least for the present—of converting any of the wooden vessels standing on the stocks at Chatham dockyard into iron-clad ships of war, and the armour-cased frigate, the frame for which is now being prepared at Chatham, will be an entirely new vessel, and will be the first of the squadron of armour-clad ships which are to be constructed from the designs of Mr. E. J. Reed. The new frigate is intended to be a superior ship, both in point of speed, offensive and defensive power, and sea-going qualities, to any of the armour-clads lately constructed, and the Admiralty have decided on naming her the *Lord Warden*, in compliment to Lord Palmerston. The blocks for the *Lord Warden* have been laid on No. 7 slip, and every effort is to be made to have her completed and afloat within 18 months from the present time.

THE "CONSTANCE."—The Admiralty, acting upon a suggestion originally made by us, and their attention having been directed to the success of several vessels fitted by the firm of Randolph, Elder, and Company, of Glasgow, determined upon instituting trials to ascertain the applicability of the modern innovations introduced by this form, to our ships of war. In order as far as possible to put all the competitors on equal terms, the Lords of the Admiralty selected three frigates of the same model, built at Pembroke, as nearly as possible from the same lines as those of Sir W. Symonds, with similar midship sections, and having about an equal draught of water. The *Arethusa*, 3141 tons, has been supplied with engines by Messrs. John Penn and Son, the *Octavia*, 3161 tons, has received hers from Messrs. Maudslay; and the *Constance*, 3213 tons, is fitted by Messrs. Randolph, Elder, and Co., of Glasgow. The engines of the *Constance* are the first engines supplied by this firm for the Royal Navy, and it speaks pretty plainly as to the opinion formed of their success in the vessels of the Pacific Steam Navigation Company, that the Admiralty should allow them to contract for engines of such a size. One feature in the engines of the *Constance* makes them somewhat different from others previously constructed by Messrs. Randolph, Elder, and Company, they are adapted for screw propulsion instead of the paddle wheel, and owing to the requirements of ships of war, the entire machinery has to be kept below the water-line. The three ships are not the best adapted for steam vessels, from the fact, that like all Sir W. Symonds' designs, they are very sharp in the floor. The average consumption of coal in the Royal Navy is estimated at the present time as between 3 to 4lb. per indicated horse power; and one of the main objects of the competitive trials is to endeavour to prove the possibility of reducing the consumption to a little over 2lbs. To gain this saving of fuel it was necessary to make the engines of the *Constance* heavier, larger, and consequently more expensive than those of corresponding power on board other ships. It is, however, but justice to the manufacturers to state that much of the weight is to be attributed to a desire to retain the means of reverting to the present mode of working, should the new mode be found unsuccessful. In consequence of this desire the boilers fitted to this ship are much larger than are requisite for her new engines. The dimensions of the *Constance* now are—Length, 252ft., over all, 280ft.; extreme breadth, 52ft.; tonnage, 3142 tons. The masts were not yet stepped. Her draught, with 80 tons of coal, and 70 tons of water, is 17ft. forward, and 20ft. 9in. aft. The builders of the engine have supplied her with a pair of what are termed double cylinders, or compound engines of 500 horse power combined, which are bedded in a block of solid cast-iron weighing 50 tons. Well up on each side of the engine-room she is fitted with three cylinders, the pistons from which work directly on the crank shaft. There are three cranks, each of which receives two connecting rods. The middle cylinders are high pressure, the other four are low pressure expanding cylinders. The diameter of the middle cylinder is 60in., and the other 78in. The cylinders are jacketed throughout, in addition to a casing of felt and mahogany. There are three cranks—one to each pair of opposite cylinders, the motion being by ordinary connecting rods. Stroke, 39in. The eccentrics, four in number, are placed immediately at the back of the foremost crank, the pin of which overhangs. The eccentrics are loose upon the shaft, and are worked by means of two pinions moving in interior arcs cut in the bodies of the eccentrics. The spindles of these pinions pass through the overhanging crank pin, and are worked by means of a series of wheels and pinions attached to two starting donkies. On the side of the foremost eccentric are two strong pins, which are brought by means of these starting donkies to catches on the crank itself, as may be required for ahead or astern. The engines are thus very easily started or reversed, and as the eccentrics and the whole of the gearing is made of wrought-iron and is of great strength, there is no reason to expect accident from fracture, or undue wear in the number of wheels. Along the fronts of each set of cylinders are two sets of shafts for working the slides. There are three sets of slide valves to each engine—the slides for the admission of steam to the high pressure cylinder, and the slides for the regulation of the steam from the centre to the two outer cylinders. The gab lever on the shaft for working the high pressure slide valve is so constructed as to admit of its being lengthened or shortened, and thereby increasing or decreasing the travel of the valve, thus varying within certain limits the cut off of the steam, or in other words varying the degree of expansion which can be used in the smaller cylinder. The condensers are on the system patented in this country by Mr. Davison, a modification of the system known as Sewells, in which the steam is condensed by contact with the outer surface of the tubes, the water passing through them. The condensing water is drawn through the tubes by circulating pumps, and, by means of a series of plates or partitions at each end, the water is made to traverse the whole length of the condenser three times before passing through the pumps to the discharge pipe. The action of the surface condensers can, if required, be changed while the engines are in motion, and the engines can be worked in the ordinary way by sea-injection. When all are in action, the steam is expanded partially in the high pressure cylinders, and from them still further into the low pressure cylinders, down to a pressure of about 10lb. below the atmosphere before it escapes into the condensers. Such a degree of expansion is difficult to obtain practically with any other class of engines in consequence of the unequal action of the steam in the cylinders. Each condenser contains 1308 tubes, or 2616 in the two condensers, the external surface of which, for condensation, is 5848 square feet, being rather more than 11·5 square feet per nominal horse power. The tubes of the condensers are packed so that when they require cleaning they can be easily removed and replaced; each tube is 11ft. 5in. long. The total length of the 2616 tubes is over five and a half miles. The *Constance* has four boilers, partially superheating, with six furnaces to each boiler. The firegrate surface is about ·55 square feet per nominal horse-power. The diameter of the propeller shaft is 15in., its length from the sternmost coupling to the thrust block 80ft., and from the thrust block to the engine, 13ft. 11in. The length of the boss of the screw, one of Griffith's double-bladed, is 4ft. 6in.; diameter of screw, 18ft.; and pitch, $27\frac{1}{2}$ft. The weight of the engines is 180 tons, of the boilers 160 tons, and of the water in the boilers 70 tons. The stowage for coal is 280 tons, the consumption of coal by ordinary engines would be from 70 to 80 tons per day; by the new engines it is expected that about 50 tons daily will be sufficient. On the 9th ult. the *Constance* left the Hamoaze. In consequence of the strength of the easterly wind, from 4 to 6, and partly on account of heated bearings, it was deemed inexpedient to test the engines formally at the measured mile, and she went accordingly round the Eddystone. On this trip her speed was twice tested by log line, when no special efforts were used for propulsion, and a rate of over 10 knots was indicated. The revolutions varied from 55 to 62 per minute, steam pressure about 30lb., barometer pressure vacuum 28in., condenser 26in. The action of the screw did not create much trembling motion. The hot bearings consisted of the heating of some of the collars of the journals, which have all been fitted with great nicety.

AN IRON-PLATED STEAM RAM, said to be constructed for the Chinese Government, was launched from the yard of Messrs. Laird Brothers, Birkenhead, on the 4th ult. This vessel, which is about 1150 tons burthen, and nearly 230ft. in length, has a peculiar appearance. She has an unusually great beam, the plates, deck beams, and ribs being of immense strength. The inside shell of the vessel, and the shell below the water mark is covered by planking 6in. thick, this planking being again covered by iron plates [illegible] in thickness. The vessel has a singular appearance in the water, being more circular than conical. The whole of the stern is composed of forging of such thickness that penetration seems nearly out of the question. The engines by which the vessel will be propelled are upwards of 350 horse power. The whole of the upper deck is plated with iron. The funnel of the vessel can be lowered at pleasure, and the masts are [illegible] to form tubes on the deck. The vessel will have two of [illegible]

The "Pheasant" Screw Gunboat, 60-horse power, with condensing engines, on the 14th ult. made a trial of her machinery on the completion of her outfit. The vessel drew 6ft. 6in. forward, and 6ft. 8in. aft. Six runs were made at the mile, and a speed obtained, as a mean of the six, of 7·544 knots. The screw of the vessel is of the common pattern, with a diameter of 6ft. and a pitch of 8ft., a length of 11in., and an immersion of the upper edge of 2in.

Trial Trip of the "Messaggiere."—A trial trip of a new despatch steamer or *aviso*, built by Messrs. Money Wigram and Penn, for the Italian Government, took place on the 20th ult. The new boat, which is constructed on similar lines to one built by the same firm for the King of Italy a few months since, is 250ft. in length between perpendiculars, 30ft. in breadth, and carries engines of 350-horse power. They are of 5ft. stroke, and their cylinders are 71in. in diameter. The paddle-wheels are over 23ft. in diameter, and are fitted with feathering floats. The engines are oscillating, and the boilers are on the tubular system. The trip extended from Tilbury Fort to a little beyond Sea Reach, and the speed attained in running the measured mile was at the rate of 17 knots, or 19·6 miles an hour. The *Messaggiere* had taken on board over 180 tons of coal, besides nearly the same amount of stores and spare gear, which caused her to draw almost a foot more water than she would have done under ordinary circumstances. With a normal load there appears to be little doubt of her running at a speed of 17¼ or even 17½ knots an hour.

Naval Appointments.—The following appointments have taken place since our last:—J. J. Greathead, Chief Engineer, to the *Cumberland*, from the *Mars*; T. Duncanson, Chief Engineer, to the *Cumberland*, from the *Conqueror*; S. T. Wallis, Assistant Engineer, to the *Asia*, for hospital treatment; T. Cross, Assistant Engineer, to the *Defence*; W. G. Warren and W. Maxwell, Engineers, to the *Fisgard* and *Asia*, as Supernumeraries; W. Wynd, Engineer, to the *Cumberland*, from the *Sheerness*; W. Robinson, Engineer, to the *Wye*; M. J. Shannon, Assistant Engineer, to the *Asia*, for hospital treatment; C. S. Uffindell, Assistant Engineer, to the *Fisgard*, as Supernumerary; H. F. Struguell, Assistant Engineer, to the *Asia*, as Supernumerary; J. M. Brankston, of the *Osprey*, promoted to Acting 1st class Assistant Engineer; P. Hutchison, of the *Himalaya*; W. H. Banbury, of the *Dart*; J. Rice, of the *Asia*, as Supernumerary; H. Benbow, of the *Cornwallis*, W. Inglis, (a) of the *Osprey*, and J. Jessop, of the *Black Prince*, promoted to the rank of Engineers; W. Ross, of the *Foxhound*, promoted to Acting Engineer; J. West, of the *Columbine*, promoted to Engineer; V. C. Friend, Assistant Engineer, to the *Indus* for hospital treatment; T. Vickery, Assistant Engineer, to the *Resistance*; J. D. Chater, Assistant Engineer, to the *Cumberland*, as Supernumerary; W. H. Sennet, Assistant Engineer, to the *Indus*, as Supernumerary; M. Barker, Supernumerary in the *Indus*, promoted to Engineer; T. Young and R. Spiers, Assistant Engineers, to the *Indus* and *Fisgard* respectively, for hospital treatment; J. P. Lloyd, Engineer to the *Indus*, for the *Ripple*; E. Taylor, Engineer, to the *Indus*, as Supernumerary; R. Biddle, Engineer, to the *Himalaya*; and W. R. Leeson, Acting Engineer, to the *Fisgard*, as Supernumerary.

MILITARY ENGINEERING

Experiments at Shoeburyness.—On the 7th ult., another of a series of armour plate experiments took place. The target was invented by Mr. George Clark, and consisted of seven plates of various thicknesses, from three to five and half inches of iron; each plate, except the third or fourth towards the centre, having a different backing as regards thickness of angle iron, &c.; but all being formed upon the general principle that the best method of meeting the concussion of the shot beneath the armour-plate is, according to Mr. Clark's theory, by a cellular system of wrought iron webs, either vertical or horizontal, the cells in every case being filled in either with pitch, pine, teak, or millboard packing. The ordeal to which this target was intended to be submitted was the same as that by which the Warrior and all other targets are tried, and which may be summarized by stating that it begins with heavy shells filled with sand and fired at low velocities, gradually increasing to live shells, then to solid shot with small charges and low velocities, and, lastly, to salvoes of shot with full charges. Shells, whether empty or filled with sand, have no perceptible effect on any iron target; so that this portion of the programme was abandoned, and firing commenced at once with 68-pounder live shell. After the first three with live shell, all the succeeding rounds until the firing in salvo commenced were with the smooth-bore 68-pounder gun, with cast-iron shot and the full service charge of 16lb. of powder. The effects these produced may be summed up in the few words that though the target stood better than was expected, it from the first showed signs of giving way. The rivets at the back went fast and early, and the bolt-heads, the main fastenings of the plates, gave way also with a rapidity much greater than is usual. Six had gone before the salvoes commenced; the plates were deeply indented and buckling up, and one or two ribs at the back of all were bending outwards. The plates, which were rolled at the Millwall Ironworks, were of admirable quality, and, though dented and bent, showed no signs of cracking, nor did they give any marks of yielding where the deep slots had been cut in them at the back to hold the bolt-bars. The last of the 68-pounders fired struck on plate No. 7, and broke though it. This plate, however, was only three inches in thickness. A salvo of three 110-pounders with 14lb. of powder, and two 68's with 16lb. of powder, was then fired simultaneously, but only four of the guns went off. The united blows of these four, however, shook the whole target most seriously, and cracked its largest plate almost completely across. The Armstrong 300 or 150-pounder, according as it is used with spherical or elongated projectiles, was loaded and laid. This most formidable piece—which no target has ever yet entirely resisted—was loaded with 50lb. of powder and a round shot of 150lb. weight. The effect of this was instant. With a terrific crash it smashed through the thickest (5½in) plate of the target, through cells and backing and inner skin—shivering into matchwood one after the other two of the massive beams which shored up the target from behind, and, ploughing into the earth beyond. Beams, bolts, and plate had all alike been scattered into fragments before the passage of this missile. It was the general opinion, judging from the smashing the shot had inflicted after its passage through the target, and the prolonged flight its sound showed it had made through the air afterwards, that had a second target of the same kind been behind the first it would in all probability have gone through both. In other words, had a ship been constructed on the principle of this target, it would have gone in at one side and out at the other, making the same ruin of both. One more shot was fired from the same gun with a reduced charge of 35lb. of powder, but with a steel shell of 300lb. weight, loaded with a 15lb. bursting charge of powder. This, notwithstanding the reduction of firing charge, went as clean through another plate of 4in. as its predecessor had done through the 5½in., the explosion of the shell shaking all the rest of the fabric.

Gun Experiments.—The superintendent of the gun factories, Mr. Anderson, has received orders for the construction of a few powerful muzzle-loading guns for the naval service; they are proposed to be rifled and fired with very heavy charges. The security of the breech of the gun, on which the principal strain falls, is to be much increased by an improved method of construction lately proposed by Mr. Anderson. This alteration consists in having a solid block of steel bored out for the interior tube, and then a solid forging shrunk over it, which enables the breech screw to be dispensed with, and gives much more solidity than heretofore to the structure of large ordnance. Mr. Anderson has also proposed to make the smaller guns of much greater strength, for it has been found necessary to shorten the 12-pounders by cutting off 14in. from their muzzles, and to fire them with the reduced charge of powder and shot issued for the 9-pounders supplied to the Horse Artillery. There will, however, by this change be the great advantage of having only one charge of powder and the same shot for both Horse Artillery and Foot Artillery field-pieces.

Krupp's Cast-Steel Guns.—In a recent number of a Turin journal, a notice on the manufacture of cast-steel ordnance, by Signor Picolo Pelati, mining engineer, appeared from which we extract the following table on the proportions and process of Krupp's, guns, all the figures denote the English weights, measures, and coinage.

Diameter of Bore.	Thickness of metal at the breech.	Length of Bore.		Approximate weight. Of the rough Casting.		Approximate weight. Of the finished piece of Ordnance.		Price. Of the rough Casting.	Price. Of the finished piece of Ordnance.
Ins.	Ins.	Ft. In.	Ft. In.	Lbs.		Lbs.		£ s. d.	£ s. d.
2·56	1·77	4 3·12	....	495	......	346	......	33 15 7	60 0 0
2·56	2·56	4 3·12	....	716	......	540	......	48 15 7	76 9 7
3·07	2·20	4 8·28	5 11·64	577	1047	577	743	55 16 10	86 4 10
		to						to	to
3·07	3·07	4 8·28	5 11·64	1102	1433	812	1073	97 17 7	135 0 0
3·31	2·36	4 3·12	4 8·28	826	908	607	676	55 16 10	86 6 5
3.31	2·75	4 3·12	4 8·28	992	1102	749	831	to	to
3·31	3·31	4 3·12	4 8·28	1157	1294	882	985	86 4 10	120 0 0
3·58	2·56	5 6·48	5 11·64	1344	1426	908	963	91 10 5	129 15 7
		to						to	to
3·58	3·58	5 6·48	5 11·64	1790	1928	1322	1432	131 4 10	174 0 0
3·82	2·75	6 9·84	7 3·00	1917	2050	1366	1477	127 9 7	174 15 7
								to	to
3·82	3·82	6 9·84	7 3·00	2590	2726	1884	2010	140 16 0	217 9 7
4·60	2·75	7 8·04	8 1·20	2424	2535	1569	1653	150 0 0	210 0 0
4·60	3·07	7 8·04	8 1·20	2733	2865	1840	1928	to	to
4·60	4·60	7 8·04	8 1·20	4159	4408	3001	3196	275 9 7	347 9 7
5·12	3·46	8 6·24	....	3747	......	2424	......	240 0 0	311 5 7
								to	to
5·12	5·12	8 6·24	....	5730	......	4214	......	367 9 7	441 0 0
5·86	3·66	8 6·24	8 11·40	4606	4765	2975	3035	292 9 7	382 9 7
5·86	3·94	8 6·24	8 11·40	5180	5400	3553	3692	to	to
5·86	5·86	8 6·24	8 11·40	7604	8045	5592	5951	525 0 0	623 5 7
8·19	6·14	94·56	....	12453	......	8816	......	810 0 0	975 0 0

Armour Plates.—A code of regulations for the guidance of the officials and others engaged in bending and preparing the slabs of iron used in armour plating the iron frigate *Achilles*, 50, and the other vessels under construction at Chatham dockyard, has been promulgated by order of the Lords of the Admiralty, and is to be strictly adhered to. The regulations are drawn up from the report of the Armour Plate Committee appointed by the Admiralty, of which Captain Sir John C. D. Hay was the chairman. The committee included a number of scientific officers belonging to both branches of the service. The Committee, in their report to the Admiralty, state that they have examined the various processes adopted in bending the iron plates, and are of opinion that the plates need not suffer deterioration in quality from any reasonable degree of bending, provided the process is properly performed. It is the nature of wrought iron to admit of such changes of shape without injury. The most essential preparation for the process of bending is that the plate should be sufficiently heated, for it is only under this condition that it will acquire the ductility and softness and freedom from elasticity necessary to admit freely the change of shape. The committee consider that a good red heat is probably the minimum that will suffice; "bloodred" or "cherry red" is hardly sufficient. The committee, however, deem it necessary that certain precautions should be taken in the process of heating the plates—1st. That the heat be not carried to such an extent as to injure the iron; 2nd. That the heating be done gradually, so as to heat the large mass uniformly throughout its substance; and 3rd. To have the heating surface so arranged as to prevent fierce fire currents from impinging on the edges or sharp arrisses of the plates, by which damage would be done. Probably from good red to brightest red are the safest limits; and, provided the proper precautions be taken, there is reason to believe that the quality of the plate will be rather improved by the heating than otherwise, as, if the iron happens to be hard, the process will be equivalent to annealing, and will render the metal softer. The process of heating adopted at Portsmouth in the presence of the committee appears to comply with the required conditions, and the committee believe the quality of the plates so bent to be well retained. The mode of bending the heated plates is a matter which the committee conceive may be safely left to the mechanical advisers of the Admiralty. The wedge and tap process, as adopted at Portsmouth, has the advantage of simplicity; but the committee think it would be better if the change of shape could be effected by dead pressure—hydraulic, for example—instead of by blows. The committee consider it highly inexpedient to bend thick plates cold, or only slightly heated, as there are very few kinds of iron sufficiently ductile to bend cold, even in small bars, without injury to the structure of the metal, and in large masses this attempt must be injurious, for even if the external surface should escape injury the process will inevitably produce undue internal strains, very detrimental to the powers of resistance under the blows of shot.

Rifled Ordnance.—A new code of regulations, to be adopted in all future trials o rifled ordnance, has been received at the Ordnance Department, Chatham, from the War Department, and is to be strictly adhered to. The regulations hitherto in force are abolished, and in future all rifled guns are to be proved by firing two rounds with the service charge of powder and a cylinder, equal in weight to two service shots; and three rounds with a service shot, and a charge of one-sixth the weight of the service projectile, as at present, for those guns the service charge for which is one-eighth, and in the same proportion for guns having a larger charge. The following alteration in the system of proof of brass ordnance, which has been recently approved in India, has been ordered to be adopted in this country:—The piece to be proved when ·08 inch below the true calibre, and afterwards finished. This alteration has been adopted in consequence of its having been observed that the effect of the proof charge upon brass ordnance, when fired with the usual windage, is in almost all cases to leave serious indentations near the seat of the shot. Indentations so caused will, by this system, be removed in finishing the gun.

Trial of Armour Plates at Portsmouth.—A trial took place on the 2nd ult. of armour plates at the practice range in Porchester-creek. The plates on trial consisted of one from Messrs. John Brown and Co., of Sheffield, for the iron-cased ship *Ocean*, 15ft.

in length by 3ft. 3in. in width and 4½in. in thickness, and one 4½in. plate 6ft. by 4, made under the steam hammer in Portsmouth Dockyard from a special quality of iron, stated to be foreign, supplied by Messrs. Walton, Sons, and Yates, of London. This last plate was virtually destroyed by the first shot, and utterly so by the second. The plate furnished by Messrs. Brown, for the *Ocean*, underwent a very severe testing by 13 shots (nine of which were edge blows, in three instances overlapping each other), very successfully, and fully maintained the reputation of its manufacturers.

FORTIFICATIONS.—The schedule to the Fortifications Bill states the proposed expenditure at Portsmouth and the Isle of Wight, Plymouth, Pembroke, Portland, Gravesend, Medway and Sheerness, Chatham, Dover, Cork, and for site for a central arsenal. The total estimated cost is £6,920,000; the amount already voted, £3,200,000, whereof £2,041,449 had been expended by the 31st of March last; the further sum now proposed is £650,000, leaving £3,070,000 to be voted in future years.

STEAM SHIPPING.

TRIAL TRIP OF THE "OCEAN KING."—On the 11th ult. a trial trip of this steamer was made at Sunderland. The *Ocean King* was built by Messrs. Pile and Hay, of North Sand, her engines, which are of 90 horse-power, being manufactured by Mr. G. Clarke, of Monkwearmouth. She has a false bottom which, by a simple process, can be filled with water for ballast, and emptied as may be required. With a cargo of 1050 tons of coal she attained a speed of 10 knots per hour.

TRIAL TRIP OF THE TWIN-SCREW STEAMER "DIANA."—The trial trip of this vessel took place on the 30th of June last, and the results have been pronounced very successful. The following are the most important particulars:—

	h. m. s.		m. s.
No. 1. Full speed ahead	2 36 20		
Stopped	0 37 34	diff.	1 14
114 revolutions way astern	0 39 10	„	1 36
„ „ full speed	0 39 40	„	0 30
Evolutions completed in	0 3 20		

	h. m. s.	m. s.	
No. 2. Full speed ahead, helm hard a starboard	2 44 30	4 20	1st circle.
	0 48 40	4 18	2nd „
120 revolutions	0 53 18	3 44	3rd „
	0 57 2		
mean of three = 4 7·33			

Diameter of circle described 3½ times length of vessel. No. 3. One engine full speed ahead, helm hard a starboard—

	m. s.	h. m. s.		
half circle	1 24	3 9 20	= 3 50	1st circle.
completed	1 26	0 13 10		
half circle	2 0		= 4 16	2nd „
completed	2 16	0 17 26		

The way being deadened and wind on the bow caused slight retardation. No. 4. Engines working in opposition, starboard ahead, port astern—

h. m. s.	m. s.		m. s.
3 20 12	3 36		
0 23 48	5 19	mean	4 27 5
0 29 7			

To test the power of turning to avoid danger or pick up a man. Full speed ahead; helm suddenly put a starboard, port engine reversed—

	m. s.
Half turn	1 25

The manœuvre of steering by the screws in going stern foremost, was then put under severe trial and performed admirably, but the greater depth of the keel and after body demanded very accurate steamship. We trust soon to learn that Government will adopt more decisive measures for the introduction of this important aid to manœuvring ships-of-war.

THE "EUPHRATES," BUILT FOR THE BRITISH EAST INDIAN STEAM NAVIGATION COMPANY, was launched from the yard of Messrs. A. and J. Inglis, Govan, on the 2nd ult. Her dimensions are:—Length of keel and forerake, 200ft.; breadth of beam, 28ft.; and depth of hold, 16ft. 6in., with direct acting engines of 120-horse power.

THE "PRINCESS ROYAL," an iron screw steamship of 800 tons burthen, the property of the London and Limerick Steam Shipping Company, was launched from the yard of Messrs. Blackwood and Gordon, Port Glasgow, on the 4th ult. She will be propelled by a pair of direct-acting inverted condensing engines, of 110-horse power, and will be schooner rigged.

THE ROYAL PADDLE YACHT "OSBORNE" made an official trial of her machinery at Portsmouth on the 15th ult., under the superintendence of Captain H. Broadhead, commanding her Majesty's ship *Asia* and the Steam Reserve, on the completion of her general repairs and her fitment with new wheels on the feathering float principle by Messrs. Maudslay, Field, and Son. The yacht was complete in coal and stores of every description for sea service, and her draught of water was—forward, 14ft. 6in., and aft, 14ft. 1½in. The new wheels are 28ft. in diameter, with a breadth of float of 3ft. 8in., and a length of 10ft. 7in., the immersion of the upper edge of the lower float being 6in. The diameter of the new wheel is thus about 18in. less than the old wheels. Six runs were made at the measured mile with full boiler power, giving the following results in knots:—12·413, 12·203, 12·766, 11·841, 13·186, and 11·501. Four runs at half-boiler power gave 12·456, 9·045, 12·486, and 9·207. The revolutions of the engines at full power ranged from 21¼ to 22½, and at half-power remained steady at 18½. The speed attained by the yacht with her new wheels is nearly three-quarters of a knot in excess of what she realized when a new vessel 20 years since, and the trial may therefore be considered satisfactory.

LAUNCHES.

LAUNCH OF A WOODEN VESSEL BUILT ON A NEW PRINCIPLE.—On the 10th ult. a barque named the *Virginia* was launched at Liverpool from the building yard of Mr. John Robinson. The *Virginia* is a ship of somewhat peculiar construction, the principle having been patented. Her bottom is flat, and she has three keels, in addition to which only straight timber is employed in the building. Her length is 115ft., beam 23ft., and depth of hold 12ft. Her registered tonnage is 200 tons, but has carrying capacity equal to 500 tons, and is classed for seven years at Lloyd's. The time occupied in building the *Virginia* was only 40 days and 40 nights, and she was launched with her masts and a portion of her rigging fitted.

LAUNCH OF THE "ALEXANDRA."—The *Alexandra*, screw steamer, was launched on the 2nd ult., from the Thames Shipbuilding Company's yard, Blackwall, for the fleet of the re-organised London and Mediterranean Steam Navigation Company. This steamer, which is of 1000 tons, was built in the short space of four months. The dimensions of the *Alexandra* are as follows:—Length between perpendiculars, 210ft.; extreme breadth, 30ft.; depth of hold, 18ft.; tonnage, 919 14-94. In the rig there will be no peculiarity, that adopted being a three-masted schooner. In the construction of the hull 400 tons of iron are used, and it may be remarked that two plates of Muntz's metal are attached to the rudder to test the efficiency of Mr. J. B. Daft's insulated metal sheathing.

THE LAUNCH OF THE "ALEXANDRA," built for the Australian colonies at Deptford-Green Dockyard, by Mr. C. Lungley, took place on the 18th ult. The following are her dimensions:—Length between perpendiculars, 200ft.; breadth over all, 28ft.; and depth of hold, 11·6ft.; tonnage, builders measurement, 586 ⁸⁄₉₄ tons.

TELEGRAPHIC ENGINEERING.

THE MALTA AND ALEXANDRIA TELEGRAPH.—All hopes of immediately repairing the injured link of the Malta and Alexandria cable have been abandoned. Messrs. Canning and De Santy, the representatives of Messrs. Glass, Elliot, and Co., will return at once to England, and Mr. Gibson, Government Inspector, will return to his post at Malta. It was at first inferred that the defect was a mechanical one and near the shore, if not actually in the harbour at Alexandria. The tests were begun under this impression, but, after a series of careful experiments, the scientific operators were led to change their opinion, and to look for the fault further away, probably close to Benghazi. It is now likely that it will be necessary to obtain the assistance of a steamer from England specially adapted to effect the anticipated repairs, in which case the interruption of telegraphic communication between Alexandria and Benghazi may extend to several months.

RAILWAYS.

INDIAN RAILWAYS.—Mr. J. Danvers, in his annual sketch of the position of Indian railways, of which he is government director, reports that 2528 miles are now open for passenger and goods traffic. The great triangular railway, connecting Madras with Bombay, Bombay with Delhi, and Delhi with Calcutta, will be complete in about twelve months. The amount already raised for these works is forty eight millions and a quarter, which large sum is in the hands of only 31,400 persons, an average of £1500 each. The shares are evidently used for permanent investments almost inclusively.

NEW LOCOMOTIVES.—Mr. Beattie, the locomotive superintendent of the London and South Western Railway, is building a new class of six-wheel express engines for that line, to have 17in. cylinders and four coupled wheels 7ft. in diameter.

NORTHERN OF SPAIN RAILWAY.—A passenger train has at last traversed the celebrated passage of the Guadarama, which employed 20,000 men for many months. Communication is now complete between Madrid and Olazagoitia at the foot of the Pyrenees, a distance of 390 miles. About sixty miles more remain to be executed through the Pyrenees between Olazagoigia and Irun, where a junction will be effected with one of the great French networks. It is expected that by April, 1864, passengers will be able to travel from Madrid to Paris without once leaving the railway. The total expenditure upon this important system already exceeds £10,000,000, and at least another million will be absorbed in the passage of the Pyrenees.

THE CALCUTTA AND SOUTH-EASTERN RAILWAY.—The Calcutta and South-Eastern Railway has completed the whole distance from Calcutta to the Mutlah, twenty-eight miles, and was opened on the 15th of May. The new port, which is intended as an auxiliary to the port on the Hooghly, was designated by Lord Canning the Birkenhead of Calcutta, and it has been determined to honour his memory by giving it the official name of Canningtown. It is now ten years since Lord Dalhousie, with the view of relieving the over-crowded port of Calcutta, laid down the plan of a new harbour at the Mutlah, and in the interval the shipping has more than doubled. Arrangements have been made for the accommodation of vessels at the new port. The river has been again surveyed and buoyed, and a floating light-ship has been stationed at the entrance. A chart of the river has been published by the Admiralty. An establishment of pilots has been appointed by Government, and the pilotage and harbour dues have been fixed by Act I., 1863, on favourite terms. A screw pile jetty was sent out at the beginning of the year, alongside of which vessels of the largest tonnage will be able to lie and transfer their cargoes to the trucks which will convey them to the terminus at Calcutta, whence they will be distributed to the warehouses of the merchants by an arrangement with the carrying company. The dangers of the Hooghly are unknown in the Mutlah, and a vessel with the aid of steam can always go up and down in a single day. The tides vary from 2¼ to 4 miles an hour, and two vessels like the *Great Eastern* could steam up abreast in it and turn in the port.

A NEW RAILWAY SIGNAL.—A new signal on the Midland Railway, passing Kegworth, may now be observed. It consists of a clock, with a face 4ft. in diameter, placed on the top of a column 15ft. high. Only a square of the clock is shown, which is formed of ground glass, with red figures 0.5.10.15., and has only one hand. Attached to the clock is a long rod connected with a treadle about 10ft. long, which lies along the inside of one of the rails. On the train passing over the treadle it is depressed slightly by the wheel flange, and the clock hand is set at liberty and is so adjusted by a counterpoise that it turns to figure 0. Immediately the train has passed over the hand begins again to mark the time up to 15 minutes, when it is stopped, thus indicating to the next train exactly how long up to 15 minutes the preceding train has passed the signal. The same clock works two faces, one for the up and one for the down line. The signal is illuminated at night. The simplicity of this signal is such that it is almost an impossibility for it to get out of order, and it is so arranged that a passing train takes off all pressure from the clock, so that the great difficulty hitherto experienced in self-working signals is successfully overcome. The Midland Railway Company, who have erected the one above described, have every reason to be satisfied with the results of the experiment. It is calculated that when adopted double the number of trains may be safely passed over the line that can be passed over now. The inventor of this contrivance is Mr. John King.

PROGRESS OF THE MODANE AND BARDONÈCHE TUNNEL.—The directors of the works of the Modane and Bardonèche tunnel have published their report at Turin. It appears that at the close of 1862 the total length of the tunnel pierced was 2199 metres, viz., 1274 on the Bardonèche and 925 on the Modane side. The measures taken for increasing the supply of compressed air were successful. As regards the time necessary for completing the work, the directors express a belief that it will be considerably shorter than 12½ years, the limit lately calculated by the Minister of Public Works. The convention with France allows 25 years. The total length of the tunnel being 12,220 metres, the expense, calculated at 5000f. per metre, will amount to about 60 millions of francs. The railroad from Bardonèche to Susa will be 40 kilometres in length, with a gradient of 19,324 per 1000 and 6500 metres through tunnels, the longest of which, near Exilles, will measure 1170 metres.

RAILWAY EXTENSION.—LONDON, CHATHAM, AND DOVER RAILWAY.—This line is now for the first time in possession of the through line running over their own property, between the two terminal stations, London and Dover. The Dulwich station of this line is situated about a mile from Herne-hill, and about two miles from the latter place will be the temporary depôt for the Crystal Palace, and which will be used until the opening of the Crystal Palace and South London Railway in the beginning of 1865. On account of the treacherous nature of the London clay through which it is driven it has been found necessary to arch it in several places with 12 layers of brick, eight layers being the minimum in any part. The total number of bricks used in its construction is 32,000,000, or 10,000,000 more than are contained in the whole Exhibition building. At its southern end the nine main lines of the Brighton and South-Eastern are crossed, but during the whole of the work no interruption of their traffic took place. Just beyond this spot is

Penge station, and about a mile further on the junction with the main line to Dover is reached. The distance from Victoria station to Beckenham by the new line will be $8\frac{1}{4}$ miles instead of $11\frac{3}{4}$ by the present route, and from Beckenham to the Elephant and Castle the distance will be $7\frac{3}{4}$ miles. Although there will be a saving of three miles on the whole distance, and the gradients are much easier than those on the West-end and Crystal Palace Railway, the company will not lessen the time in which trains run from London to Dover until the new line is perfectly consolidated. Herne-hill will be the junction station for all the London, Chatham, and Dover through trains. Those coming from Victoria and from the Elephant and Castle will be united, and the up trains will be separated at this station.

French new Railway System.—An inquiry is open at the present moment in the departments of the Seine and Seine-et-Oise, relative to a proposed railway which is to be laid down in a direct line, traversing all the inequalities of the surface of the country, from Paris to Marly-de-Roi. The concession for the proposed line has been made to M. le Baron Séquier, represented by M. Duméril, C.E., and is the result of demonstrations made at the Palace of the Tuileries of the advantages of a system laid before the Academy of Sciences, on the 18th of December, 1843, by M. le Baron Séquier. M. Séquier thus explains an invention which has remained for twenty years as a little model:—"We supply the cause of movement to locomotives by the pressure by springs of their wheels against rails and not in the simple adherence of the wheels to the rails by the weight alone of the machine. An ordinary railway, with simply a third rail of wood or iron laid down between the other two; locomotives nearly the same as those we have at present, only their driving wheels changing their places, and our problem is solved. Let us explain:—We propose that the two driving wheels, placed horizontally and acted on by very powerful springs, shall grasp the central rail—firmly fixed to the sleepers—between them, as a train of rolls does a bar of iron. The adhesion of the wheels then due to the pressure of the springs secures the fulcrum necessary for the propulsion of the engine and train. The power of the springs, then, which force the wheels horizontally against the rails, becomes the measure of the capabilities of the machine, instead of its weight. All attempts at producing a light locomotive have hitherto failed, because weight is necessary to adhesion. Here we see this difficulty at once overcome. A simple enlargement of the central rail, acted on, on inclines by smaller wheels on the same axle, suffice to augment the power of the locomotive. Thus, in a moment speed can be converted into tractive power or the reverse."

Railway Travelling in India.—The striking feature in the passenger traffic in India still continues to be the enormous preponderance of third-class passengers. In the year ending June 30, 1862, there were 61,817 first-class passengers, and 299,820 second-class, but no less than 6,447,055 third-class, to whom may be added 342,958 who travelled fourth-class while carriages of that class were run.

RAILWAY ACCIDENTS.

Railway Accident at Wolverhampton.—On the 6th ult. an accident happened on the London and North Western Railway, at Wolverhampton, which occasioned personal injuries to a great number of persons. The third-class train which leaves Liverpool at 7·15 a.m. was a quarter-of-an-hour late on arriving at Stafford. On account of this delay an engine that usually leaves the shed of this company near to the Bushbury Junction, at Wolverhampton, to take up a train at the passenger station, was not allowed to pass the Bushbury Junction at the customary hour. At 12.45 the Liverpool train had duly arrived at the ticket platform of the Wolverhampton station, and the officers had scarcely commenced to collect the tickets when an alarm was raised that a collision was about to happen. The collectors left the carriages, closed the doors, and the engine and tender that had been kept waiting at the Bushbury Junction came up at a speed of about eight or ten miles an hour, and ran into the rear of the train, which was a very long one. The force of the collision shattered the end and sides of the guard's break van, materially damaging two third-class carriages which were next to it.

Extraordinary Railway Disaster.—On June 28th, a train which had left Sighthill goods station, near Glasgow, for the north, was approaching Larbert station, when the engine got off the rails, dragging after it a greater portion of the train, and blocking up both lines of rails. The concussion caused by the sudden stoppage having smashed some of the leading trucks, the *débris* of these caught fire from the engine,—communicating the fire to other trucks, said to be loaded with petroleum, paraffin oil, and other inflammable material—and before it was extinguished no fewer than twelve trucks, with their contents, were consumed. The line was got cleared by mid-day. Fortunately no one was injured.

Accident on the Monmouthshire Railway.—An accident happened on the 5th ult to a passenger train of the West Midland Railway, travelling on the Monmouthshire line, by which one person was killed and several seriously injured. The trains of the West Midland Company run over the Monmouthshire Railway from Pontypool-road to Newport, and on this occasion the 11.5 train from Worcester, due at Newport at 1.60, travelled safely down to Pontypool-road. This train does not stop between Pontypool-road and Newport (8 miles), and had got about half-way between the two stations, when as it passed a small local station, called Cwmbran, and while travelling at a speed of about 30 miles an hour, the engine and train suddenly left the line, and dashed against the platform of the station. The collision threw the train bodily to the other side of the line, causing the carriages to be thrown upon the platform.

BOILER EXPLOSIONS.

Manchester Association for the Prevention of Steam Boiler Explosions.—At the ordinary monthly meeting of this association, held on June 30th, 1863, the chief engineer presented his monthly report, of which the following is an abstract:—During the past month, there have been examined 340 engines—2 specially; 528 boilers—15 specially, 12 internally, 104 thoroughly, and 402 externally, in which the following defects have been found:—Fracture, 8 (2 dangerous); corrosion, 34 (3 dangerous); safety-valves out of order, 9; water gauges ditto, 21; pressure gauges ditto, 9; feed apparatus ditto, 2; blow-out apparatus ditto, 35; fusible plugs ditto, 13; furnaces out of shape, 4 (2 dangerous); over pressure, 2 (both dangerous); blistered plates, 3; Total, 140 (9 dangerous.) Boilers without glass water gauges, 8; without pressure gauges, 2; without blow-out apparatus, 13; without back pressure valves, 39. Explosions.—"No 10 explosion. The fact of this explosion having occurred, was stated in last month's report, but no detailed particulars had then been received. It has been since ascertained that the boiler was a plain cylindrical egg-ended one, externally fired, and that the explosion was caused by rents commencing at the seams over the furnace, which has so frequently been found to be the case in this class of boiler, and called attention to in these reports. Two other explosions of a very similar character have happened during this month, particulars of which are given. Nine explosions have occurred during the last month, by which eleven persons have been killed, and twenty-one others injured. One of these explosions, which resulted from collapse of the flue, and by which no injury was done either to persons or surrounding property, occurred to a boiler under the inspection of this association; while in the eight remaining cases, not one of the boilers was under its care. No. 11 explosion occurred to the boiler of a locomotive engine while running with a passenger train. Between fifty and sixty persons were injured and four killed. This result was not occasioned, however, by the explosion only, but principally by the train running off the line. Whether the engine leaving the rails was the cause or the effect of the explosion, is an interesting question, and one now undergoing strict investigation. No. 12 explosion, from which five persons were killed and twelve others injured, took place at an ironworks. The boiler in question, which was not under the care of this association, was personally examined shortly after the explosion happened, and found to be of cylindrical egg-ended construction, having an internal flue of horse-shoe shape, both the inlet and outlet of which passed through the further end of the boiler, the remainder of the flue being quite independent of the shell, and thus not forming any longitudinal tie from front to back. The boiler was externally fired, the flame first passing underneath the shell, and then entering the flue at one leg of the horse-shoe, and escaping to the chimney through the other. The length of the shell was twenty-eight feet, the diameter eight feet six inches, and the thickness of the plate seven-sixteenths, while the blowing off pressure was about 40lb. The boiler had rent completely into two parts at the fourth transverse seam from the front end, the larger portion of the shell flying forwards in a straight line from its seat, turning a summersault in its course, and landing in a position quite the reverse of its original one; the egg-end pointing to the brickwork seating and the open one from it. The smaller portion had flown to a much greater distance than the other, and not, as is usually the case, in a direction immediately opposite, but at right angles to it. A sister boiler working alongside, and connected to the one in question, was moved laterally, sufficiently so to disturb the brickwork seating and break the steampipes, though not to unseat it altogether. With regard to the cause of the explosion. The boiler was fifteen years old, the plates over the furnace had already been repaired, and it was stated that the seams at that part had been observed to be leaking only a quarter of an hour before the explosion took place; while in addition, the shell was found to be patched in several places, and the plates cracked from the rivet holes to the edge. It is concluded, therefore, on consideration of all the circumstances, that the boiler could not have been in good condition, the correctness of which it is thought derives some corroboration from the fact, that the boiler alongside was found at the time of making this examination to be also leaking at the seams over the furnace, and that considerably, although not under pressure. An examination of the fractures, as well as a consideration of the direction in which the parts had flown, led to the conclusion that the rent had commenced at a longitudinal seam of rivets, extending for some two or three plates over the furnace. The rent ran along as far as this longitudinal seam extended, and when met by a plate crossing it, or breaking joint, as it is termed, then developed into a transverse rent, and completely severed the shell in two. It is thought that the fact of this longitudinal rent in the furnace end of the shell, being situated on one side of the centre or keel line, accounts for that portion having been blown laterally, and that the upward direction which it had evidently taken, had caused the summersault of the remaining and larger portion. The explosion, therefore, is attributed to the imperfect condition of the boiler, and although such defects would not be dangerous in a suitably-constructed, double-flued, or "Lancashire" boiler, which is always internally fired, they are generally found to be fatal in those boilers which are fired externally; while in the present case the effect was aggravated by the fact of the seams of rivets over the fire being in line, and the diameter of the shell being as much as 8ft. 6in. No. 13 explosion, by which no one was injured or the surrounding property damaged, occurred to a boiler under the inspection of this association, the particulars of which are as follows:—The boiler was an upright furnace one, working in connection with two others of similar construction to itself. It was heated by the flames passing off from a furnace employed in preparing heavy forgings; the flames passing through an internal tube in the centre of the boiler, which ran directly from the top to the bottom. The extreme height of this internal flue was 26ft. 2in., but it was not of one diameter throughout. In order to admit of a brickwork lining to guard the flue above water line, the upper part was made of a larger diameter than the remainder, and attached to it by a flanged plate which formed a set-off or shelf on which the brickwork rested; again, the lower portion of the tube had a bell-mouth at the bottom, to afford an easy entrance for the flame. The length of the upper part was 11ft. 4in., and the diameter 3ft. 3in.; the length of the intermediate portion was 10ft. 4in., and the diameter 2ft. 6in.; while the length of the bell-mouth was 4ft. 6in., and the diameter at the base, 3ft., the thickness of the plates being three-eighths of an inch throughout, and the blowing-off pressure 55lb. The explosion, which did not in any way disturb the original position of the boiler, resulted from collapse of the internal flue tube, the collapse being confined to the intermediate portion just described, which it rent at about the middle of its length. A tube of such small dimensions as those given, namely, only 10ft. 6in. in length, and 2ft. 6in. in diameter, made of plate three-eighths in thickness, if of good material and workmanship as this one was, would be amply sufficient for a pressure of 55lb., if working under ordinary circumstances. This would suggest the conclusion that the water supply had been allowed to run short, but no positive indications of the plates having been over heated appeared upon examination, though this may, however, have taken place on previous occasions without its being known. On account of the height of these upright furnace boilers, the glass guages become inaccessible, and the one in question was fitted with two gauge taps only, carried down by means of syphon pipes to within reach from the floor. Thus the water could sink below the proper level without affording any external indication, and would consequently pass unknown, should the gauge taps be neglected. This may have happened without any immediate collapse of the tube taking place, although the flue would be materially weakened by it, and rendered liable to give way some time after in consequence. It is impossible to say whether the flue tube was getting out of shape or not, since the boiler had been in such constant work that no opportunity was afforded the association of making an internal and thorough examination for upwards of three years. This may not therefore be an improper time for calling attention to the importance generally, of having spare boilers, so that a suitable opportunity may be afforded for examination, as well as for cleaning and repair. The boiler was found to be heavily incrusted with hard scale, which must considerably have tended to the overheating and weakening of the flue, to which these vertical boilers are always prone, from the tendency of the ascending steam to cling around the tube and prevent the contact of the water. The inaccessibility of the gauges, and fittings of these vertical boilers, on account of their height, is another disadvantage connected with them, and indeed a thoroughly good and safe furnace boiler must still be considered as a desideratum. No. 16 explosion happened at an ironworks, to an externally-fired boiler 40ft. long, 8ft. in diameter, made of plates seven-sixteenths of an inch thick. The shell of the boiler gave way immediately over the furnace, the fireman being scalded to death from the stream of hot water issuing from the rent. The boiler had been repaired at this part, by putting on a new plate two months previous to the explosion, and it was at this plate that the rent occurred. This boiler, which was not under the charge of this association, was not personally examined on the occurrence of the explosion, but an engineer who inspected it shortly after has kindly furnished the following particulars:—The plate ripped open through the solid metal in two places, the rents being about fifteen inches long and one inch wide; while the parts surrounding it were a good deal cracked and the seams patched, so that the bottom of the boiler was evidently in a very defective state. The ruptured plate was about seven-sixteenths of an inch thick, and did not appear of very good quality, as if not thoroughly welded in rolling; but the fractures were not, properly speaking, 'blisters,' since the whole thickness of the plate had come down at once. In addition to the inferior character of the plate, the boiler was heavily coated with incrustation, and this had accumulated at the bottom for a depth of 3in. just over the fracture, and extended for a space of 4ft. by 2ft. This mud had hardened so much that the water and steam ploughed but a small hole through it in rushing out. There can be little question

that this coating of mud had kept the water away from the plate, and thus led to its becoming overheated, from which it gave way. There was plenty of water in the boiler at the time of the rupture.

Boiler Explosion near Dewsbury.—On June 27th a boiler explosion causing the death of several workmen took place at a mill situate near Dewsbury, on the Leeds, Bradford, and Halifax Railway. The works are let to five persons, or firms, the main building being a five-storied factory, some four yards long by ten broad, and within its walls processes incident to the manufacture of cloth have been carried on for about two years. Within the building, but at the east end, was a low-pressure engine, and at the gable end was a boiler-house of two stories, containing a double-flued Cornish boiler. It was this boiler which exploded. The boiler-house was levelled to the ground, the engine-house shared a similar fate; the engine-beam being broken, and other portions of the machinery twisted and torn, and the gable end of the factory is knocked down to the lowest storey. The engine chimney, which is 36 yards high, was cracked from top to bottom.

ACCIDENTS TO MINES, MACHINERY, &c.

Explosion of Firedamp in Glamorganshire.—On June 27th an explosion of firedamp, accompanied with loss of life to several men, and much injury to persons and property, occurred at the Park Colliery, Glamorganshire. The mine in question, which is situated at a place called Baglan, Britonferry, is worked by Messrs. Thomas and Co., and gives employment to about 150 workmen. At the time the explosion took place the greater part of these were above ground.

Colliery Explosion at Ruabon.—Two men were killed by an explosion of fire damp, at midnight on the 16th ult., at the Wynnstay Colliery, Ruabon. They had gone to their work as usual, about 700 yards from the pit's mouth, and before their descent their safety lamps were carefully locked by the man appointed. About 40 persons were at work in other parts of the pit. An explosion was heard, when the managers descended and found the men dead, an accumulation of fire damp had taken place, and it was manifest that both men had broken open their lamps.

WATER SUPPLY.

Dublin Waterworks—Turning the course of the River Vartry.—The ceremony of diverting the course of the River Vartry, for the purpose of constructing a water-tight dam at the principal steerage reservoir of the intended Dublin Waterworks, near the village of Roundwood, in the county of Wicklow, recently took place. There is to be a water-tight dam across the valley of the Vartry, half a mile long, and nearly 70ft. high in the centre. It will be about 330ft. wide at the base, and so broad at the top that an ordinary country road will be constructed on its summit level. The embankment may be said to consist of three parts—a central core of about ten or twelve feet thick, and two sloping sides, which taper from a base of, say 150 to 180ft. to a summit of about 15 or 20ft. This core, which passes along the whole length of the bank, consists of a water-tight material, called "puddle," but which is, in fact, brick clay, made into a substance like putty, by carefully mixing with water. This "puddle-wall," or "puddle-trench," must be based on a water-tight foundation and be impacted against a water-tight connection with the natural strata wherever it is placed; and for that purpose the water-tight foundation must be reached at every point, as on that chiefly depends the safety of the bank. In some banks in England the foundation had to be sunk one hundred feet to reach the sound stratum and cut off leakages. At Roundwood, an average cut of ten or twelve feet below the level bed of the river has been sufficient. To reach this under the bed of the river, the river must be diverted—and to procure a water-tight passage for the pipes through the embankment—a special structure had to be made that will be in effect a tunnel through the artificial bank. For a time the water will be allowed to flow freely through the new cut, which is about 14ft. by 10ft. Hereafter, when the bank will be completed, pipes with valves will be laid in this cut—the cut plugged up, the valves closed, and the water accumulated in the storage reservoir, to be let down through the valves as required. In order to enable the diversion to be effected without the risk of injury to the bank, the driest season has been chosen, and that in which the water may be expected to be very low. Thus, the old river bed may be excavated and the water-tight bank constructed on its site, before the advent of any serious flood.

GAS SUPPLY.

Imperial Gas Company.—The directors of this company have recommenced a dividend of 10 per cent. per annum, free of income tax: they have also been authorized to borrow £50,000 by mortgage, for the extension of mains and works.

The Kelso Gas Company have declared a dividend of 10 per cent.

The Wisbeach Gas Company.—The prosperous condition of this Company has enabled the directors to increase the rate of dividend, and to lower the price of gas to 4s. 6d. per 1000 cubic feet.

The Salisbury Gas Company have reduced their price of gas to 4s. 6d.

The Bristol Gas Company, in reply to a committee of the Bristol Gas Consumers' Association, have declined to reduce the price of gas to 3s. per 1000ft. The committee announce that they are in a position to justify their making application to Parliament in the next Session for a Bill to incorporate a rival company.

The Peterborough Gas Company recommend a dividend of 8½ per cent. A lowering of meter rents has increased the number of their consumers.

The Worcester Gas Company announce a reduction in price to 4s. 6d.

The Halesworth Gaslight Company have declared a dividend of 7½ per cent.

The Galashiels Gas Company announced a dividend of 7½ per cent., and a reduction in their charge from 6s. 5½d. to 5s. 10d.

The Brechin Gas Company's declared dividend is 10 per cent.

The Cambridge Gas Company have declared a dividend at the rate of 10 per cent. per annum.

The Boston Gas Company report prosperously of their affairs, and declare a dividend of 8½ per cent.

SEWERAGE WORKS.

Metropolitan Main Drainage.—A visit has been paid by members of both Houses of Parliament to the outfall of the southern system of Main Drainage, Mr. Bazalgette explaining to them the nature of the works. As will be remembered, on each side of the river there are three main tunnels or sewers, which divide underground London into three districts, known respectively as the High, the Low, and the Middle Level. These in their course intercept all existing sewers flowing into the Thames, and carry their contents to Barking Creek on the north side, and to Crossness Point in the Erith marshes on the south side. The High Level, on the north side, is about eight miles in length, and runs from Hampstead to Bow, being at its rise 4ft. 6in. in diameter, and thence increasing in circumference as the waters of the sewers it intercepts require a wider course, to 5ft., 6ft., 7ft., 10ft. 8in., 11ft. 6in., and at its termination, near Lea river, to 12ft. 6in. in diameter. Its minimum fall is 2ft. in the mile; its maximum, at the beginning, nearly 50ft. in the mile. It is laid at a depth of from 20ft. to 26ft. below the ground, and drains an area of fourteen square miles. The Middle Level, as being lower in the valley of the slope of which London is built, is laid at a greater depth, varying from 30ft. to 36ft., and even more, below the surface. This is nearly complete, and extends from Kensal Green to Bow. The Low Level will extend from Cremorne to Abbey Mills, on the marshes near Stratford, and one portion of it will pass through the Thames embankment. At Bow, the Low Level waters of the sewer will be raised by engines at a pumping station to the junction of the High and Middle Level ducts, thence descending by their own gravity through these tunnels to the main reservoir and final fall at Barking. On the south side of the Thames the three great sewer arteries are constructed on similar plans,—the High Level from Dulwich to Deptford; the middle from Clapham to Deptford; and the low level from Putney to Deptford. At this point is a pumping station, which raises the water from the low to the high level, whence it flows away through a 10 feet tunnel to Crossness Point. One part of this tunnel, passing under Woolwich, is a mile and a half in length, without a break, and driven at a depth of 80 feet from the surface. At the outfall will be another pumping station, to lift the water to the reservoir. The southern reservoir is only five acres in extent; that on the north is fourteen. In the reservoir it will be deodorized. The two culverts which carry the sewage to the east and west pumping stations are as large almost as railway tunnels. Before the entrance to the pumps are massive iron strainers, which keep out all the coarse refuse brought down the sewer, and which is afterwards dredged up by the filth hoist into the filth chamber, which is flushed into the river at low water. The pumping-house is nearly finished, and the ironwork of the engines begun. The pumping stations will each consist of an engine house, containing ten boilers calculated to work up to 500 horse power nominal. This power working through eight pumps of 7 feet diameter and 4 feet stroke will daily raise [illegible] feet of sewage from 19 feet below low water to the level of the outfall; but, in case of necessity, the pumps can raise 25,000,000 cubic feet per day. The reservoir into which it will flow is not yet finished, but when roofed in with brick will hold [illegible] gallons of sewage.

DOCKS, HARBOURS, BRIDGES, &c.

Proposed Pier at Aldborough.—A project is on foot for erecting a wrought iron pier at Aldborough, Suffolk. It is proposed to run it out 500ft., that is to the outer edge of the inner shore, so as to command 10ft. of water at the lowest spring tides. The cost of construction is estimated at £5000.

MINES, METALLURGY, &c.

Metallic Alloy.—Mr. A. L. Woolf, of Birmingham, proposes the use of an alloy as a substitute for gold, consisting of copper from 90 to 100 parts; aluminium, 5 to 7½ parts; and gold, 2½ parts. The alloy formed is described as very closely resembling fine gold.

APPLIED CHEMISTRY.

On the Substitution of Soluble Glass for the Resinous Soap used in the Manufacture of Ordinary Soap, by Mr. Fr. Storer.—The idea of employing soluble glass is by no means new. Its application to this purpose was long ago proposed and patented by M. Wilson, followed by MM. Sheridan, Gossage, and others. It seems to have been recently taken up anew in England. But the American process differs notably from those previously in use, by making use of a product rich in silica, capable of forming a hard and comparatively neutral soap, instead of the extremely alkaline mixtures of the above-mentioned inventors. This constitutes another example of the rapidity with which one industrial process displaces another, previously preferred, but whose further development is impeded by circumstances. The American process commences in preparing by the dry way a silicate of soda containing five equivalents of silica and two of soda, which is dissolved by prolonged boiling in water. The solution is sometimes [illegible] by pressure. The limpid solution, freed from all insoluble impurities, is decanted and concentrated to about 35° B., 1·32 specific gravity being the state in which it is sold. After preparing by the usual process a certain quantity of pure soap with tallow, oil, or other kind of grease, and when the boiling is just finished, it is poured, while still hot and in a fluid state, into forms or moulds, and the desired quantity of concentrated solution of silicate of soda, either cold or heated, is added at the same instant. To incorporate the silicate thoroughly, the mass is stirred, until the cooling renders this operation difficult. It is then left to harden. By this process the silicate of soda becomes so perfectly incorporated with the soap that as much as 60 per cent. of this solution at [illegible] may be added, and yet yield a soap of adequate consistency. But generally not more than from 25 to 40 per cent. of silicate is added to the soap. It is this power of adding so large a proportion of alkaline silicate thoroughly saturated with silica which forms one of the great advantages of the American process. According to M. Steeber's experiments it is possible to use only small quantities of the more alkaline silicates, such as were formerly used, with hard tallow or oil soaps, for when more is added the excess separates. The experience of some American soapmakers who have recently tried to introduce 25 per cent. silicate of soda into their soaps, confirms M. Steeber's opinion. Soap prepared by the American process differs materially from ordinary rosin soap neither in appearance nor action. It has passed satisfactorily through the trial of a great demand during the past year, and appears to serve perfectly well for all the uses to which ordinary soap is applied. The American Government has already bought large quantities of it for the use of the army at a much lower price than was formerly given for resinous soaps, and it has undergone all the tests exacted by the agents of the Federal Government. We may remark that a mixture of silicate of soda and ordinary soap has been preferably used for some time in washing woollen fabrics in one of the largest establishments of the United States. Silicate of soda is useful to soapmakers for several qualities not possessed by rosin, for instance the addition of a large quantity of silicate of soda imparts to the soap neither that disagreeable odour nor the glutiness which too great a proportion of rosin communicates. It may be introduced into soap in much larger proportion than rosin without in any way injuring the sale of the product. It is not probable that rosin will ever resume its former importance to the soapmaker. It will still be used [illegible] with the silicate of soda, since a little rosin serves to correct the [illegible] of [illegible] fats, and because, according to some makers, it augments the detersive action of the soap. The use of soluble glass in hard soaps should not be confounded with the use as detergents of simple solutions of silicate of soda. The latter are simply alkaline solutions, similar to those of alkaline carbonates. They act chiefly, if not wholly, by their chemical nature, for they do not lather, and in that and other respects are unlike real soaps, whilst the silicate of soda soap, owing to the portion of fatty acid it contains, lathers abundantly, and behaves like ordinary soap, the mechanical and chemical [illegible] required by a good [illegible]. It [illegible] that silicate of soda soap is distinct from [illegible] prepared by the mechanical addition of silica or of some insoluble silicate, such as silicate of alumina, which is simply a [illegible], while in soaps containing soluble glass a portion of fatty acid, so to speak, is replaced by a weak mineral acid, [illegible] the causticity of the alkali.

Antidote for Hydrofluoric Acid.—In case of burns from this liquid, Mr. [illegible] recommends [illegible] with acetate of ammonia, and the [illegible] of [illegible] If, however, the acid has got [illegible] into [illegible], under the nails, for instance, he recommends [illegible] and remarks that the patient [illegible] very [illegible] but transient, which [illegible] the application.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated June 23rd, 1863.

1575 J. Murray—Chains or chain cables and rings.
1576 A. R. Stocker—Preparing and fashioning iron applicable to the manufacture of boot heels, tips, and horse shoes.
1577 J. Ellison & A. Rogerson—Slubbing, intermediate and roving frames, in throstles and winding machines used for the manufacture of cotton or other fibrous materials.
1578 W. W. Sleigh—Semi-nugatory motive power engine.
1579 S. Robinson, J. Priestley, & J. Foulds—Looms for weaving.
1580 T. F. Parsons—Preparing plates, bars, or other objects of iron for being coated with metals or alloys.
1581 R. A. Brooman—Breech-loading arms.
1582 W. L. & T. Winans—Steam boilers.
1583 W. L. & T. Winans—Lessening the friction of the rubbing surfaces of the slide valves of engines and of the journals of shafts.
1584 W. L. & T. Winans—Superheating steam in steam boilers.
1585 E. Brooks—Breech-loading fire arms.
1586 A. Mein—Generating steam
1587 F. Feichtinger—Paper applicable for hemorrhoidal complaints.
1588 W. Toovey — Photolithography, photozincography, and photographic engraving on copper or steel plates.

Dated June 24th, 1863.

1589 S. Knowles & R. Hayward—Plaiting and measuring woven fabrics.
1590 T. Redwood—Straining or mixing and straining liquid and solid substances.
1591 P. R. Hodge—Fleeting hydrostatic machinery adapted to presses, dry docks, slips, or the moving or lifting of heavy masses.
1592 E. Myers & W. R. Williams—Gas meters for measuring the flow of gas.
1593 S. Smith—Liquorice.
1594 J. L. Hughes—Ornamenting porcelain.
1595 T. Skinner—Ornamentation of silver, German silver, Britannia metal, electro-plated or other plated goods.
1596 A. E. Brac—Actuating domestic bells and other signals by the electric current.

Dated June 25th, 1863.

1597 A. Ripley —Packing, chiefly applicable to piston rods and pumps, and for forming the joints of gas, steam, or water pipes.
1598 C. A. Count de Goddes de Liancourt—Saving life from drowning.
1599 D. Hussey—Bobbins, and the winding of roving or yarn thereon.
1600 T. Page—Horse shoes and their fastenings.
1601 J. O. Mathieu—Twisting machines.
1602 R. Mushet—Iron and steel.
1603 W. Kirrage—Using Apo elsstikon hyphrasmn as a new and improved cloth for floors, roofs, walls, tanks, and other linings, being impervious to damp and of great strength and durability.
1604 H. G. Craig—Preparing iron and other metal plates for shipbuilding and other purposes.
1605 H. C. Lee—Sewing machines.
1606 A. Watson—Fastening.
1607 J. Head & H. Brinsmead—Thrashing machines and cutting and bruising straw.

Dated June 26th, 1863.

1608 A. Tulpin—Stretching and dyeing fabrics.
1609 W. Clark—Aerating liquids.
1610 G. Buccius — Composition suitable for the manufacture of candles and other like articles, and pomatum, and an improved wick for burning with such composition.
1611 W. E. Gedge—Placing tyres on wheels or hooping or ferruling generally while the metal is hot.
1612 J. Griffiths—Puddling iron and steel.
1613 R. Mushet—Iron and steel.

Dated June 27th, 1863.

1614 T. Dunn—Construction and maintenance of the permanent way of railways.
1615 G. Clark—Guns and projectiles, and carriages, platforms, and shields for working and protecting guns.
1616 W. & J. Bradshaw—Looms for weaving.
1617 E. T. Hughes—Couplings for hose pipes, and also connecting axles to the naves or hosses of wheels.
1618 J. Chatterton—Lining iron and other tubes and hollow vessels, and manufacturing corrugated tubes of plastic materials.

Dated June 29th, 1863.

1619 G. Davies—Cork cutting machine.
1620 W. Andrews — Insulating electric telegraph wires.
1621 C. Avery—Rotary engines.
1622 L. E. Hicks—Inkstands.

Dated June 30th, 1863.

1623 F. J. Duggan—Connecting lamp chimnies and other glasses or shades with the burners of lamps.
1624 L. F. A. B Marnlaz—Combs.
1625 J. G. Jennings & M. L. J. Lavater—Stoppers and lids or covers for jars, bottles, and other vessels, also closing and fastening other articles, and constructing and fixing packing and other rings and discs and diaphragms of vulcanised india rubber.
1626 J. Simpson—Iron hurdles and fencing.
1627 J. H. Johnson—Moulding or shaping pottery-ware.
1628 A. K. Richards—Ordnance and fire arms, and projectiles to be used therewith.
1629 C. H. Gardner—Lithographic and zincographic presses.
1630 A. Silvester—Apparatus to be used in the exhibition of dramatic and other performances.
1631 S. Cole — Clasps or fastenings for securing brooches, solitaires, and other dress ornaments.

Dated July 1st, 1863.

1632 T. Williams—Effecting or aiding in effecting the locomotion of land carriages or vehicles and floating vessels by manual power or other primary motive agency
1633 J. Blake—Reducing and regulating the pressure or quantity of steam, and discharging the water of condensed steam from cylinders, pipes, and other vessels.
1634 T. Alliston & R. Swift—Metallic joints for bedsteads, and the application of such joints to certain parts of bedsteads.
1635 W. Snell—Waterproof material.
1636 T. Boyle — Promoting ventilation in every description of dwelling place and building.
1637 C. P. Coles—Working guns in vessels and forts, and discharging them under water.
1638 R. C. Clapham—Hyposulphite of soda, sulphite of soda, and sulphite of lime.
1639 J. H Johnson—Coating or covering metal sheets with metals or alloys.
1640 J. & J. S. Harvey—Cutting tobacco into cakes suitable for the press.
1641 T. Taylor—Railway breaks.
1642 H. Hutchinson—Boots and shoes.
1643 G. T. Bousfield—Preparing cotton, wool, or other fibrous material.
1644 J. & J. Cole, jun.—Looms for weaving.

Dated July 2nd, 1863.

1645 J. J. Shedlock—Wet gas meters.
1646 R. A. Brooman—Protecting metals and metallic articles from oxidation, and coating slate, bricks, pottery, and ceramic ware.
1647 A. A. Croll—Purification of gas for illumination.
1648 E. Lloyd—Waterproofing, softening, and preserving all kinds of wearing leather, rendering old hard leather soft and pliable and impervious to wet, particularly boots and shoes, carriage harness, gig aprons, carriage heads, and mill bands.
1649 W. Miller—Evaporating through the combined agencies of heat and centrifugal force.
1650 F. Ransome—Coating or preserving iron ships or vessels, or iron used for other purposes.
1651 J. King—Fencing land and hanging gates.

Dated July 3rd, 1863.

1652 C Martin—Treatment and preparation of materials for the manufacture of paper.
1653 H. Broadhead & G. Murdoch—Breech loading ordnance, gun carriages, and concussion shells.
1654 W. E. Newton—Treatment and preservation of skins of all kinds.
1655 R. Dairson—Decorticating and cleaning corn and other grain.
1656 C. Baulch—Boots and shoes.
1657 H. Brinsmead—Cooking apparatus.
1658 H. Thomas—Candlesticks.
1659 H. S. Warner—Treating or preparing megass and other substances to be used as fuel.
1660 E. Lelios—Churning.

Dated July 4th, 1863.

1661 J. C. MacDonald & J. Calverley—Printing apparatus.
1662 M. E. Eyth—Rotative engine.
1663 J. MacDonald—Jacquard looms.
1664 R. Flude & J. Farndon—Looms for weaving narrow fabrics.
1665 J. Grimson—Shuttles for weaving narrow fabrics and mounting and fitting them to the batiens.
1666 H. A. Bonneville—Steam engines.
1667 H. A. Bonneville—Obtaining motive power.
1668 H. A. Bonneville—Telegraph wires.
1669 A. Norman—Apparatus for fanning or fur agitating air.
1670 J. Oxley—Filtering apparatus.
1671 G. A. Barrett, W. Exall, C. J. Andrews, A. Barrett, & J. L. Bowhay—Thrashing machines.

Dated July 6th, 1863.

1672 A. & B. S. Gower—Sowing and harrowing machine.
1673 J. Samuel—Gas for lighting and heating purposes.
1674 W. B. Adams—Wheels and their tires, axles, and axle boxes.
1675 T. W. Couldery—Attaching boxes to hold soap, black lead, or similar household articles to the sides of wash-tubs, pails, or house buxes.
1676 J. McG. Croft—Propellers for propelling ships.
1677 S. J. Cooke—Supplying carbonic acid gas to casks or other vessels containing beer or other fermented liquid.
1678 H. Caunter—Lubricating matter or composition.
1679 B. Bonfield—Stoppers for bottles.
1680 G. C. Collyer—Treatment of cut tobacco for its better preservation.

Dated July 7th, 1863.

1681 C. Schiele—Turbines.
1682 L. J. Guichard & G. F. J. Lefebre—Lamps for burning mineral oils.
1683 W. S. Bruce—Lucifer matches, fusees, and other similar lights.
1684 E. Edwards—Glass finger plates and other articles made of glass, and kilns for annealing articles made of glass.
1685 G. Bartholomew—Shoes for the feet of horses and other animals, and the means of connecting them.
1686 J. Orr—Weaving piled and other fabrics.
1687 W. E Gedge—Seats, chairs, sofas, lounges, and other similar articles of furniture.
1688 W. E. Gedge—Apparatus for milking.
1689 S. Robinson—Spring hinges for swing doors.
1690 G. P. P. Reed—Watches or timekeepers.

Dated July 8th, 1863.

1691 E. Myers & H. Forbes—Propelling and steering ships.
1692 G. Haseltine—Brick machines.
1693 W. Basford—Generating and purifying gas.
1694 F. Ely — Composition applicable to corn plasters.
1695 H. Armstrong—Alum.
1696 J. Gibson, S., R., & W. Trulock—Breech-loading fire-arms.
1697 P. A. L. de Fontainemoreau—Roofing houses.
1698 T. Preece—Corn and seed drill.
1699 A. G. Southby—Diverse lamps.
1700 R. & L. A. Tallerman—Waterproofing and ventilating boots, shoes, and slippers.
1701 G. Haseltine—Lever horse-power machines.
1702 W. E. Newton—Locks and fastenings.
1703 H. D. P. Cunningham—Working guns.
1704 J. Thomas—Treating ores and earths containing iron.

Dated July 9th, 1863.

1705 S. Davis—Anatomical bit for horses or other animals.
1706 J. Smith & S. A. Chease—Hydraulic engine.
1707 W. Williams—Shirt collars and boys' and ladies' collars.
1708 R. Phillipson & W. Bond—Temples for looms.
1709 R. A. Brooman—Ships and propelling the same.
1710 P. G. B. Westmacott—Cranes and dock-gate and other crabs.
1711 J. F. Delany & J. C. R. Okes—Pistons of steam engines.
1712 P G. B. Westmacott—Hydraulic engines.
1713 W. V Wilson—Red colouring matter.
1714 R. Agate—Roofs and other lights for railway stations, conservatories, and other structures.
1715 W. E Newton—Barometers or gauges for measuring the pressure of fluids.
1716 W. Tent—Pins or hooks for suspending fabrics.
1717 G. Gowland—Nautical and surveying instruments.
1718 W. Tasker—Thrashing machines.

Dated July 10th, 1863.

1719 P. A Godefroy—Purifying oils.
1720 A. R. Johnston—Portable fence.
1721 M A. F. Meunons—Protecting the silvering of mirrors.
1722 J. J. Shedlock—Soil pits.
1723 C. de Bergue—Piles for foundations and piers.
1724 W. Clark—Ornamental lace.
1725 T. Legg & R. Griffith—Sewing machines.
1726 R. Hornsby, jun., J. Bonnall, & W. Astbury—Traction engines and apparatus for ploughing and tilling land.
1727 W. E Jones—Permanent way of railways.
1728 W. Henderson—Treating ores and other substances containing iron
1729 J. P. Bourquin—Rolling press.
1730 J. Campbell—Permanent way of railways.
1731 R. & W. Hawthorn—Working of railways.
1732 L. Stilic—Galvanic batteries.

Dated July 11th, 1863.

1733 E. D. Chattaway—Railway signals.
1734 M. W. Ruthven—Steering vessels.
1735 A. Dixon & J. Pumphrey—Coat flower clip.
1736 J. Orr, J. Brinton, & J. Lewis—Chenille.
1737 J. Barnes—Clipping off connecting threads of lace.
1738 R. A. Brooman—Cartridges.
1739 H. Greaves—Railways and tramways.

Dated July 13th, 1863.

1740 J. Mortimer—Dwelling houses.
1741 R. D. Dwyer—Casks and other vessels.
1742 H. Coulter—Burners for hydro-carbon and other fluid burning lamps.
1743 R. D. Dwyer—Letter copying presses.
1744 H. N. King—Apparatus for producing spectral illusions on the stage.
1745 J. Barton—Guard for coal and other pits.
1746 R. S. Walker—Coating iron ships.
1747 G. H. Barber — Calendar or date denoting apparatus.
1748 J. Laing—Dyeing and printing.
1749 R. A. Brooman — Suspending chandeliers, gaseliers, and other weights.
1750 R. A. Brooman—Sizing warp and weft threads.
1751 P. C. A. Iodocius—Fishing.
1752 H. A. Bonneville—Breech-loading fire-arms.

Dated July 14th, 1863.

1753 L. M. Bournique & J. B. Vidard—Railway carriages.
1754 L. M. Bournique & J. B. Vidard—Waggons for railways
1755 J. R. Cooper—Sights for rifles and other fire-arms.
1756 C. Opperman—Connecting and disconnecting horses and other animals with carriages.
1757 J. T. Cooke—Battens.
1758 J., T., & F. R. Holmes—Thrashing and dressing machines.
1759 G. Saxon—Metallic pistons.
1760 J. Davison—Furnaces.
1761 R. Hornsby & J. E. Phillips—Reaping and mowing machines.
1762 W. Wood—Covering land, bog, or peat, with earth or soil.
1763 E. Sonstadt—Sodium.
1764 W. Roberts—Ploughs.
1765 J. L. Todd—Rollers employed for spinning fibrous materials whilst in a wet state.
1766 J. Slater—Compressing bricks, tiles, and other plastic materials.

Dated July 15th, 1863.

1767 E. Funnell—Self-acting electro-magnetic clock work signal for railway purposes.
1768 T. Wimpenny—Roving and spinning wool, cotton, and other fibrous substances.
1769 D. P. Wright — Attaching the burners of paraffin and other lamps to the founts or oil containers.
1770 W. T. Cheetham—Obtaining hydraulic motive power.
1771 W. Clark—Making paper transparent and transferring designs.
1772 P. A. J. Dujardin—Electric telegraphs.
1773 M. Henry—Figuring, ornamenting, and colouring fabrics.
1774 R. A. Brooman—Reducing charcoal and other friable substances to fine or impalpable powder.
1775 R. A. Brooman—Telegraphing by electricity.
1776 D. C. Clemm—Employment of magnesia and its combinations in manufactures.
1777 D. Tamet—Breakwaters.

Dated July 16th, 1863.

1778 H. Mege—Treating fatty matters.
1779 A. Watson—Cooking ranges.
1780 S. A. Couper—Packing case to contain bottled beer, wine, or any other liquid in bottle.
1781 J. N. Taylor & W. Austin—Ships.
1782 H. Eliott—Breech-loading fire-arms.
1783 L. Priestley & J. L. Todd—Elastic boots and shoes.
1784 L. R. Bodmer—Manufacture of a new product from peat and peat tar.
1785 C. Stokes—Expanding and contracting horse collar.
1786 G. Rand—Apparatus for boiling and cooking.
1787 J. Lamb & S. Tovey—Looms for weaving carpets.
1788 A. Montleart and W. Tent—Attaching hooks to furniture and fabrics.
1789 B. Lambert—Preparation of waste paper in order to its being again used in the manufacture of paper.
1790 O. Wakefield—Cocks or taps.
1791 N. Thompson—Boat building.
1792 E. Maw—Pillars, posts, columns, mouldings, and buildings, when corrugated metal is employed.

Dated July 17th, 1863.

1793 A. J. Sedley—Canopies of bedsteads.
1794 A. C. D. Wild—Producing raised patterns on felt hats, caps, and bonnets.
1795 J. Darrieux—Powder for cleaning metals.
1796 F. Lepoutre—Mechanical sector.
1797 T. Johnson—Washing and cleansing casks.
1798 E. Alcan—Gas burners.
1799 R. A. Brooman—Varnish.
1800 G. F. Wilson and G. Payne—Soap.
1801 R. Coeneu—Winding, measuring, and sizing silk.
1802 J. H. Johnson—Machine knitting needles.

Dated July 18th, 1863.

1803 A. Clark—Revolving shutters and blinds.
1804 W. C. Page—Preventing and removing the incrustations in marine and land steam boilers.
1805 E. Holborow and I. Parker—Sights for fire-arms.
1806 G. Murdoch—Steam and vacuum gauges.
1807 F. J. Mavor—Horse shoes.

Dated July 20th, 1863.

1808 W. Simpson and J. Hutton—Hollow cutting tools.
1809 F. A. Calvert—Opening, cleaning, and preparing fibrous substances.
1810 R. B. Brassey and J. Hargreaves—Sizing and drying yarns and fabrics.
1811 T. Knowles—Cleaning cotton.
1812 J. and W. H. Bailey—Preventing boiler explosions.
1813 A. Smith—Dragging bristles.
1814 W. H. Gedge—Inland navigation.
1815 A. A. Pelaz—Printing fabrics.
1816 F. Ayckbourn—Air and water beds.
1817 J. Lyman—Micrometer draughting scales.
1818 R. Weare—Water closets.
1819 J. Goold—Ink.

Dated July 21st, 1863.

1820 F. L. H. Dauchell—Purifying water.
1821 C. H. Rueckner—Reducing wood to a fibrous condition.
1822 W. Clarke—Manufacture of fabrics in twist lace machinery.
1823 W. L Aberdein—Softening and preparing flax.
1824 C. S. Duncan—Apparatus for heating, melting, boiling, and evaporating.
1825 E. T. Bainbridge—Ventilation.
1826 J. E. Varmer—Umbrellas and parasols.
1827 G. Haseltine—Harrowing and smoothing land.
1828 R. A. Brooman—Watches.
1829 E. Alcan—Condensing steam.
1830 W. Naylor—Safety valves.
1831 W. E. Newton—Mats, straps, bands and ropes.

Dated July 22nd, 1863.

1832 P. R. Jackson—Rolling hoops and tyres.
1833 J. Ronald—Preparing and spinning hemp and flax.
1834 C. Senior—Closing, punching, and rivetting hose pipes.
1835 J. White—Pyramid and other cans for oil.
1836 C. Beslay—Making fabrics waterproof.
1837 B. B. Bertram—Advertising medium.
1838 I. Perrin—Danger signals
1839 J Simmons—Ploughs

Dated July 23rd, 1863.

1840 W Cole—Safety of window cleaners
1841 A T Holden—Springs
1842 L L J Fillion—Extinguishing chimney fires
1843 M A Soul—Expelling refuse matter from steam and sailing ships below the water line
1844 G Davies—Revolving fire-arms
1845 W and J Garforth—Preparing textile fabrics
1846 M Meisel—Regulating the speed of trains
1847 W Horton—Fire arms
1848 W Clark—Saddles
1949 T Perkins—Horse and hand rakes

LOCOMOTIVE ENGINEERING

SHARP, STEWART & CO? EXPRESS ENGINE.

FIG. 5

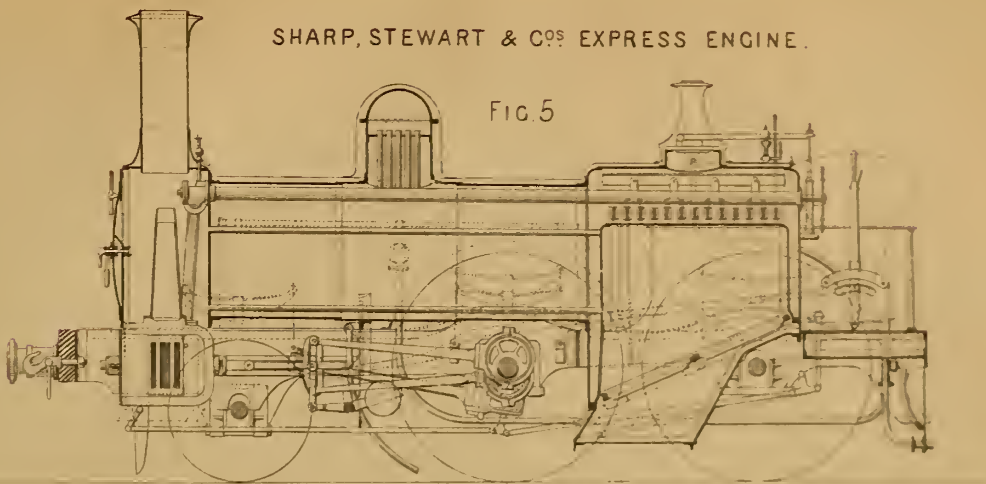
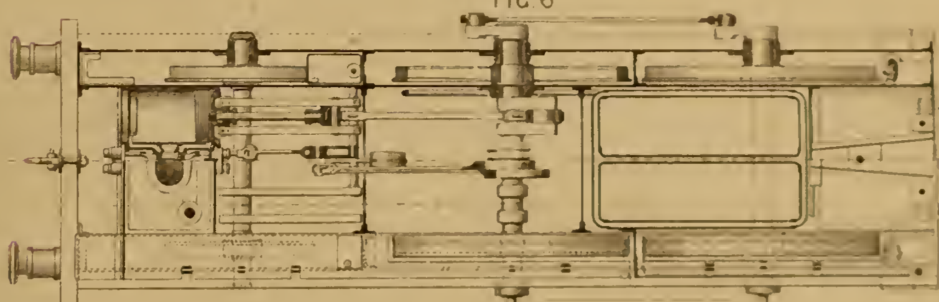


FIG. 6



RAMSBOTTOM'S STANDARD EXPRESS ENGINE

FIG. 1

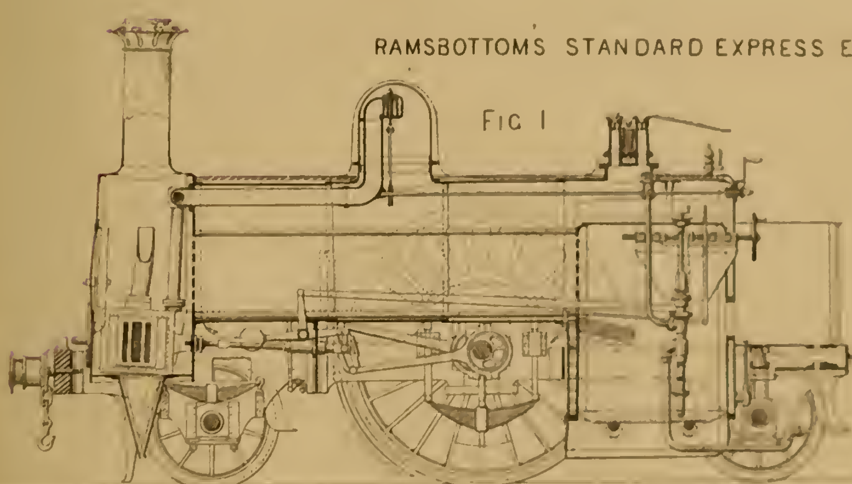


FIG. 3

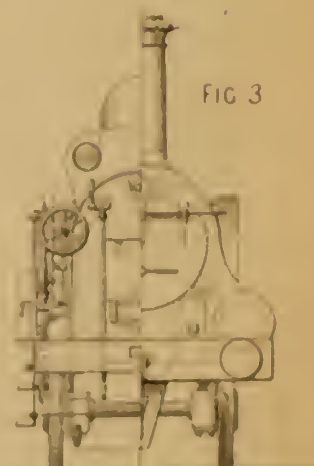


FIG. 2.

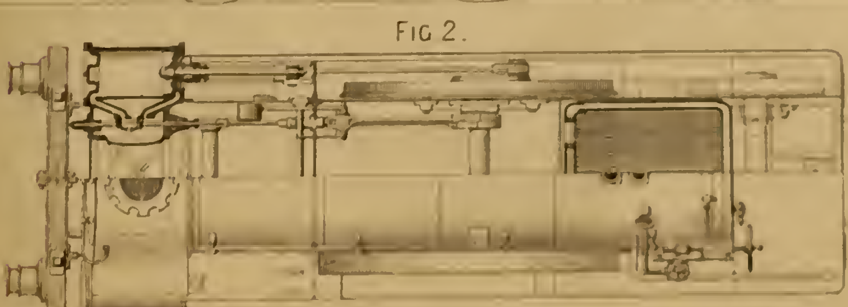
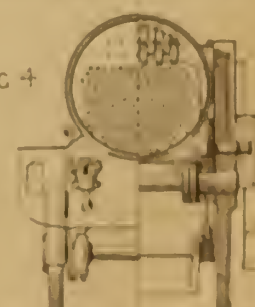


FIG. 4



1 2 3 4 5 10 15

Scale of Feet

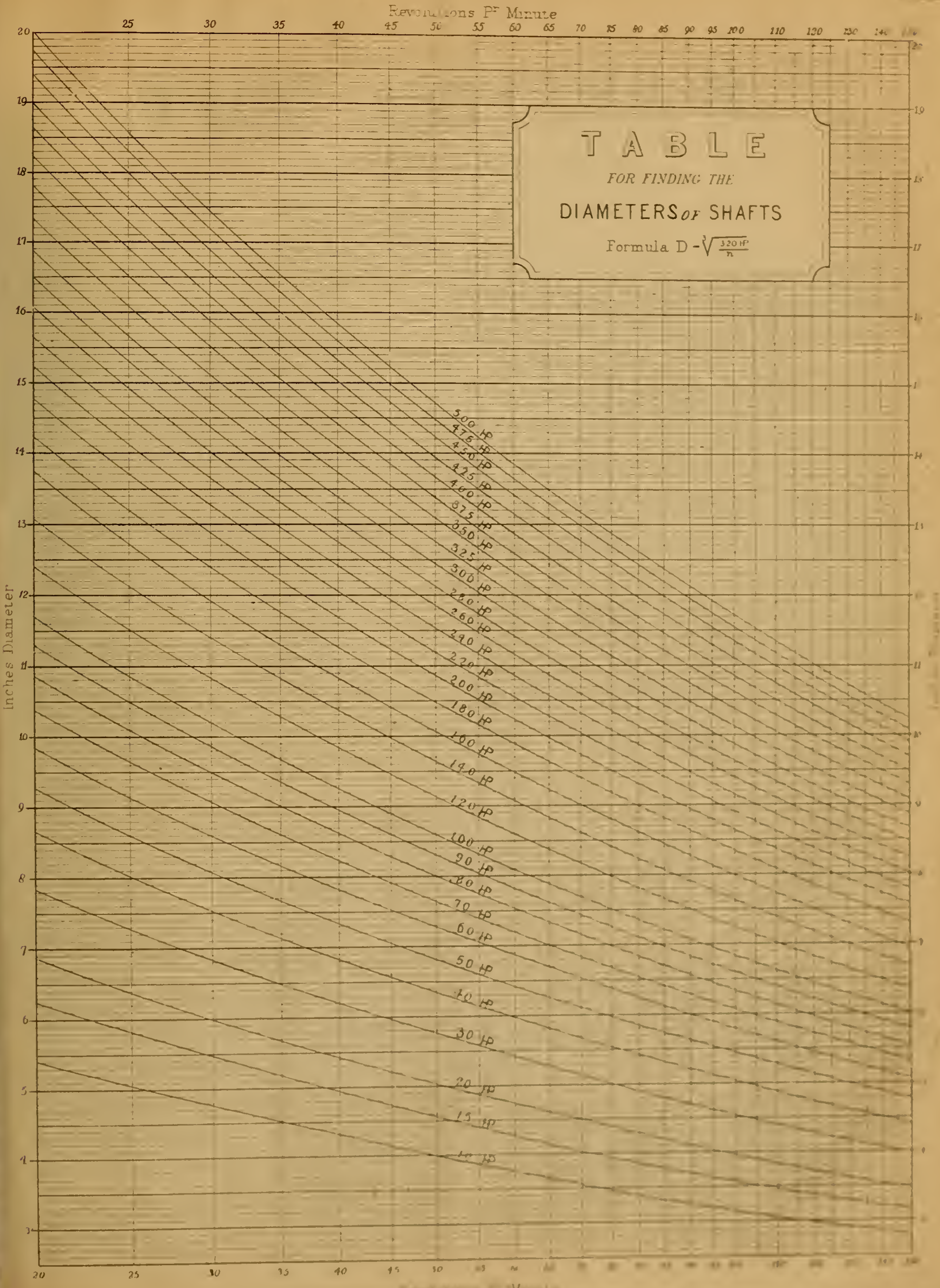


TABLE
FOR FINDING THE
DIAMETERS OF SHAFTS
Formula $D = \sqrt[3]{\frac{320\ HP}{n}}$
Revolutions P^{r} Minute
Inches Diameter
500 HP
475 HP
450 HP
425 HP
400 HP
375 HP
350 HP
325 HP
300 HP
280 HP
260 HP
240 HP
220 HP
200 HP
180 HP
160 HP
140 HP
120 HP
100 HP
90 HP
80 HP
70 HP
60 HP
50 HP
40 HP
30 HP
20 HP
15 HP
10 HP

THE ARTIZAN.

No. 9.—Vol. 1.—Third Series.

SEPTEMBER 1st, 1863.

A CRITICAL AND HISTORICAL REVIEW OF LOCOMOTIVE ENGINEERING.

By J. J. Birckel.

(Continued from page 148.—Illustrated by Plate 247.)

With a view more especially to establish a contrast between the ideas of different Locomotive Engineers, as embodied in their respective productions, we have prepared a series of copper-plate engravings, including illustrations of types of such locomotive engines, taken from the practice of various makers and locomotive superintendents as have obtained deserved repute for efficiency and durability, and which at the same time possess very distinctive characteristics. In the accompanying plate 247, the first of our series devoted to the illustration of the several types, Figures 1, 2, 3, and 4 represent Mr. Ramsbottom's standard express engine, as constructed under his superintendence at the works of the London and North-Western Railway Company, at Crewe.

This class of engines we believe, has generally to carry the Irish mail, upon that portion of the road between Stafford and Holyhead, the train consisting, on an average, of eleven carriages and a break van, which, with the engine and tender, make a gross load of about 90 tons, at a mean speed of 45 miles per hour; this duty is performed with an average consumption of 26½lbs. of coal per mile, the road between Chester and Holyhead being very heavy.

Their main dimensions and leading features are as follows:—

Boiler Barrel.—10ft. 5in. long × 3ft. 11in. diameter, made of $\frac{7}{16}$in. plates, single rivetted; height from rails to centre of barrel, 6ft. 6in.

Fire-box Shell.—Flush at the crown with the barrel, 4ft. 9in. long × 4ft. wide, made of $\frac{7}{16}$in. plates; two 2¾in. safety valves, placed on the crown of the shell, and constructed on Mr. Ramsbottom's principle.

Fire-box.—4ft. 2in. long × 3ft. 6in. wide × 5ft. 7in. deep, made of ½in. copper plates, the tube plate excepted, which is ⅞in. thick; provided with the smoke burning apparatus, described in our paper treating of the boiler. (In The Artizan of January, 1863.)

Heating Surface.—192 brass tubes, 2in. diameter × 10ft. 9in. long = 1080 square feet; fire-box, 2in. diameter × 10ft. 9in. long = 95 square feet; total 1175 square feet.

Fire Grate.—4ft. 2in. long × 3ft. 6in. wide = 14·7 square feet; fire bars, 26 in number, 1in. thick at the top, with a space of ⅝in. between them; the fire bar frame consists of two round bars of iron, 3in. diameter, resting at each end in a V seat, bolted against the ash pan side, with ⅞in. iron pegs screwed into them, at such distances as to provide an inch clear space for the fire bars. By this arrangement it is found that the latter do not solder together, as is frequently the case with the frames commonly used.

Smoke-box.—2ft 8in. long × 2ft. 11in. radius, partly enclosing the cylinders; provided at the bottom with a funnel, having an aperture of 6in. length and 1½in. width, to relieve the smoke-box of the cinders which would accumulate rapidly during the combustion of coal. By causing the front lip of the aperture to project slightly below the backlip, which is bent backwards with an easy curve, it is found that the vacuum is not impaired, while, by this very simple contrivance, the smoke-box is greatly protected against the destructive action of red hot cinders.

Chimney.—16in. diameter × 13 feet 1in. high, measured from the rails.

Cylinders.—Outside, 16in. diameter × 24in stroke, fitted with internal back cover, and with Mr. Ramsbottom's patent piston. Steam pipes, 3½in. bore; steam ports, 13½in. long × 1½in. wide; exhaust port, 3½in. wide; lap of valve, ⅞in.; blast orifice, 4½in.

Link Motion, with screw reversing gear, illustrated and described in detail in our paper on the link motion, given in The Artizan, of March, 1863; length of link 16in., throw of eccentrics, 5½in.

Feeding Apparatus.—Two medium sized Giffard's injectors placed on each side of the fire-box.

Regulator.—Double-beat valve regulator, to suit main steam pipe, 5½in. diameter.

Connecting Rod.—6ft. 3in. long, with short fork at the cylinder end; cross head pins, 2½in. diameter × 2¾in. long; crank pin bearing, 4in. diameter × 1¼in. long.

Frames.—Single inside plate frames, 1ft. 1in. apart; 13in. deep over driving fork, and 1in. thick.

Wheels and Axles.—Wheels, six in number, of solid wrought iron; driving wheels, 7ft. 6in. diameter; leading and trailing wheels, 3ft. 7½in. diameter; tyres, 5in. wide × 2½in. thick; driving axles, 7in. diameter × 7in. long in bearings, and 6½in. diameter in body; leading and trailing axles, 6in. diameter × 9½in. long in journals, and 5½in. diameter in body.

Wheel Base.—Between leading and driving wheels, 7ft. 7in.; between driving and trailing wheels, 7ft. 11in.; total, 15ft. 6in.

Springs.—Leading springs, 2ft. 8in. span, made of 14 plates, ⅜in. thick by 4½in. wide; driving springs, 3ft. span, made of 18 plates, ⅜in. thick × 4in. wide; trailing springs made of two volutes, on each side of the engine 5½in. diameter, resting in wrought iron cross frame, and butting against the foot plate by the medium of this frame.

Weight of Engine in Working Order.—On leading wheels, 9 tons 8 cwt.; on driving wheels, 11 tons 10 cwt.; on trailing wheels, 6 tons 8 cwt.; total, 27 tons 6 cwt.

Width of engine measured over all, 7ft. 9in.; length of engine measured over all, 24ft.

Figs. 5 and 6 represent an express engine as supplied to the London, Chatham, and Dover Railway Company, by Messrs. Sharp, Stewart and Co. This class of engines will take a load of 220 tons on a level road at the rate of 45 miles per hour. Their main dimensions and leading features are as follows:—

Boiler Barrel.—10ft. 6in. long × 3ft. 10in. diameter, made of $\frac{7}{16}$in. plates, single rivetted; distance from centre of barrel to rails, 6ft. 7in.

Fire-box Shell 6ft. long × 4ft. wide, made of ½in. plates, the crown projecting 6½in. above the top of the barrel; mounted with two common 3½in. safety valves, screwed down with spring balance.

Fire-box.—5ft. 3½in. long × 3ft. 6½in. wide × 5ft. 3in. deep at front, and 2ft. 9½in. at back. Contains a longitudinal mid-feather; the whole made of $\frac{7}{16}$in. copper plates, excepting the tube plate, which is [illegible]in. thick.

Heating Surface.—181 brass tubes, 2in. diameter × 10ft. 10in. long = 1026 square feet; fire-box, = 106 square feet; total, 1132 square feet.

Area of Fire Grate.—19·8 square feet; fire bars and frame placed at an angle, with the object of preventing smoke.

Smoke-box.—2ft. 3in. long × 2ft. 4[illegible]in. radius; made of ½in. plates.

Chimney.—15½in. diameter × 13ft. 3in. high, measured from the level of the rails.

Cylinders.—Inside, 17in. diameter × 22in. stroke, fitted with piston somewhat similar to Ramsbottom's; steam ports, 15[illegible]in. long × 1½in. wide; exhaust port, 3½in. wide; lap of valve, 1in.; steam pipe, 3[illegible]in. diameter.

Link Motion.—Shifting link, 16½in. long; eccentrics, 5[illegible]in. throw.

Connecting Rod, 5ft. 10in. long; bearing in cross head, 3[illegible]in. diameter × 3in. long; bearing at crank, 7in. diameter × 4[illegible]in. long; bearings of outside coupling rods, 3in. diameter × 3[illegible]in. long.

Feeding Apparatus.—Two injectors placed on each side of the fire-box.

Regulator.—Common horizontal slide valve regulator placed inside smoke-box.

Frames.—Inside and outside plate frames, 11in. deep over driving fork outside frames, ¾in. thick; inside frames, ⅞in. thick, and 4ft. 11in. apart.

Wheels and Axles.—Wheels, six in number, made of solid wrought iron; driving and trailing wheels, 6ft. 6in. diameter; tyres, 5[illegible]in. broad × 2½in. thick, dovetailed on the wheel rim; leading wheels, 4ft. diameter, with tyres 5in. broad × 2½in. thick; outside bearings of driving and trailing axles, 6in. diameter × 9in. long; inside bearings of driving axle, 6[illegible]in. diameter × 4½in. long; bearings of leading axle, 5in. diameter × 9in. long.

Wheel Base.—Between leading and driving axle, 7ft. 6in.; between driving and trailing axle, 7ft.; total, 14ft. 6in.

Springs.—All 3ft. span; leading and trailing springs, 19 plates, ⅜in. thick × 4in. wide; inside driving springs, 11 plates, ⅜in. thick × 4in. wide, and outside driving springs, 16 plates, ⅜in. thick and 4in. wide.

Weight of Engine in Working Order.—On front wheels, 9 tons 11 cwt 1 qr.; on driving wheels, 11 tons 1 qr.; on trailing wheels, 9 tons 16 cwt.; total, 30 tons 7 cwt. 2 qrs.; width of engine over all, [illegible]; length over all, 25ft. 1[illegible].

(To be continued.)

ABSTRACT OF ENGINEER'S LOG OF THE "GREAT EASTERN." EIGHTH VOYAGE FROM LIVERPOOL TO NEW YORK, JUNE AND JULY, 1863.

Date each day, ending at Noon.	Paddle Engines: Revolutions of Engines each day.	Paddle Engines: Average Revolutions per minute.	Paddle Engines: Average Pressure of Stm. in Engine-room.	Paddle Engines: Tons of Coal used each day.	Screw Engines: Revolutions of Engines each day.	Screw Engines: Average Revolutions per minute.	Screw Engines: Average Pressure of Stm. in Engine-room.	Screw Engines: Tons of Coal used each day.	Total quantity of Coal used each day.	Number of Knots run by Paddle Engines.	Number of Knots run by Screw Engines.	Distance run by Ship in Knots.	Latitude.	Longitude.	Course.	Barometer.	Observations on Rolling of Ship: Inclination to windw.	Observations on Rolling of Ship: Inclination to leeward	Observations on Rolling of Ship: No. of oscil. per min.
			lbs.	Tons			lbs.	Tons	Tons	K.	K.	K.				inches.	deg.	deg.	
June 30 ...	819	...	21	25	1,120	...	$17\frac{1}{2}$	35	60	...	...	...	...	...	...	...	...	...	...
July 1 ...	10,622	9·32	21	88	40,180	35·25	$17\frac{1}{2}$	139	227	257	290	250	Steering by the land		Various.	29·09	...	...	...
July 2 ...	8,957	9·0	21	79	40,130	35·5	$17\frac{1}{2}$	136	215	199	230	110	51·21 N.	12·3 W.	Various.	30·01	...	...	...
July 3 ...	14,603	10·0	21	109	51,980	35·5	$17\frac{1}{2}$	172	281	358	377	306	51·6 N.	20·03 W.	S. 87·18 W.	30·03	...	...	...
July 4 ...	15,466	10·45	21	111	53,310	36·0	$17\frac{1}{2}$	173	284	376	385	321	50·24 N.	28·22 W.	S. 82·28 W.	29·09	...	...	...
July 5 ...	14,890	10·15	21	112	51,610	35·0	16	173	285	360	373	299	49·30 N.	35·57 W.	S. 79·33 W.	29·09	...	...	...
July 6 ...	13,506	9·21	21	106	49,340	34·0	16	170	276	331	357	242	48·28 N.	41·50 W.	S. 57·6 W.	29·08	...	...	...
July 7 ...	15,772	10·7	21	109	52,440	36·0	17	177	286	386	380	300	47·34 N.	49·12 W.	S. ·80 W.	29·07	...	...	...
July 8 ...	15,431	10·96	21	112	49,450	35·0	17	168	280	379	359	298	45·59 N.	56·5 W.	S. 71·24 W.	29·04	...	...	...
July 9 ...	15,466	11·0	21	112	49,070	34·7	16	166	278	379	354	268	43·55 N.	61·40 W.	S. 62·25 W.	29·09	...	...	...
July 10 ...	14,561	10·2	21	111	49,660	35·0	17	172	283	352	366	202	41·40 N.	67·42 W.	S. 61·27 W.	29·07	...	...	...
July 11 ...	12,370	9·0	21	105	44,010	33·0	16	164	269	299	323	158	40 44 N.	70·45 W.	S. 67·43 W.	29·08	...	...	...
July 12 ...	9,538	10·16	21	72	29,218	33·7	16	107	179	212	212	160	Steering by the land		Various.	...	...	...	...
Total	162,001	10·22	21	1251	561,518	35·16	17	1952	3203	3888	4006	2914	...	...	...	...	...	...	...

Actual time of steaming from Liverpool to Queenstown, 19 hours. From Queenstown to Montauk Point, 9 days 20 hours and 22 minutes. From Montauk Point to Flushing Bay, 8 hours 54 minutes. Engines stopped to take soundings, 3 hours 25 minutes. Engines stopped to assist crew of schooner *Trimmer*, 3 hours 21 minutes. Total, 11 days 7 hours and 2 minutes. No observations obtained for the last 5 days; position and distances run are by account. Density of water in boilers, $1\frac{1}{2}$; vacuum in paddle engines, 26·0; ditto in screw engines, 25·0; extreme diameter of paddle wheels, 49ft.; effective diameter, 47ft. 4in. = 148·70ft. each revolution; screw, 44ft. pitch; immersion on leaving Liverpool, 23ft. 9in forward; 27ft. 6in. aft.; immersion on arriving at New York, 21ft. 2in. forward; 25ft. aft.; average daily consumption of coals by paddle engines 113·73 tons; ditto screw engines 177·45 tons; total daily consumption, 291·18 tons.

General Remarks.

June 30, at 9.25 a.m., started paddle and screw engines ahead full speed; at 11.30, stopped engines off Bell Buoy to discharge pilot, and waiting to take cargo on board; light N.W. breeze; sea smooth.

July 1, at 4.55 p.m., started engines ahead slow; at 5.5 p.m., full speed; fresh N.W. to S.S.W. breeze and cloudy; heavy sea running.

July 2, at 12 noon, paddle and screw engines working very easy; at 6.15 p.m., stopped engines, and came to anchor in Queenstown harbour; at 8.50 p.m., started engines ahead slow; at 9.45 p.m., full speed; fresh S.W.W., S.W., and W. breeze; heavy swell.

July 3, light N.W. breeze; sea smooth.

July 4, light W.S.W. breeze; sea smooth; fore and aft sails set.

July 5, light S.W. to N.W. breeze; sea smooth; fore and aft sails set.

July 6, fresh W.N.W. breeze; heavy sea running.

July 7, dense fog; engineers standing by paddle and screw engines; light W.N.W. breeze; sea smooth.

July 8, dense fog; engineers standing by paddle and screw engines; stopped engines 5 times to take soundings; engines stopped 50 minutes in all; light N.W. breeze; sea smooth.

July 9, dense fog; engineers standing by paddle and screw engines; stopped engines 54 minutes to take soundings and to clear several fishing smacks; light W. breeze; sea smooth.

July 10, dense fog; engineers standing by paddle and screw engines; stopped engines 23 minutes to take soundings; fresh W. by S. breeze; heavy sea running.

July 11, dense fog; engineers standing by paddle and screw engines; stopped engines 12 times to take soundings; engines stopped 88 minutes in all; strong S.W. breeze, and heavy sea running; ship rolling very heavily.

July 12, light W.N.W. breeze, and heavy swell; at 5.30 p.m., stopped engines off Montauk Point, to take pilot on board; 5.50 p.m., full speed; at 10.40 p.m., stopped paddle and screw engines, and reversed full speed; at 10.50 p.m., stopped engines, came in collision with schooner *Trimmer*; in passing came foul of port paddle wheel, damaging arms and several floats; engines working occasionally from 1.30 a.m. until 5.45 a.m.; dropped anchor; distance, about 12 miles from Flushing Bay.

ABSTRACT OF ENGINEER'S LOG OF THE "GREAT EASTERN." EIGHTH VOYAGE FROM NEW YORK TO LIVERPOOL, JULY AND AUGUST, 1863.

Date each day, ending at Noon.	Paddle Engines: Revolutions of Engines each day.	Paddle Engines: Average Revolutions per minute.	Paddle Engines: Average Pressure of Stm. in Engine-room.	Paddle Engines: Tons of Coal used each day.	Screw Engines: Revolutions of Engines each day.	Screw Engines: Average Revolutions per minute.	Screw Engines: Average Pressure of St'm. in Engine-room.	Screw Engines: Tons of Coal used each day.	Total quantity of Coal used each day.	Number of Knots run by Paddle Engines.	Number of Knots run by Screw Engines.	Distance run by Ship in Knots.	Latitude.	Longitude.	Course.	Barometer.	Observations on Rolling of Ship: Inclination to windwd.	Observations on Rolling of Ship: Inclination to leeward	Observations on Rolling of Ship: No. of oscil. per min.
			lbs.	Tons			lbs.	Tons	Tons	K.	K.	K.				inches.	deg.	deg.	
July 21 ...	...	...	...	25	...	...	...	35	60*	...	...	...	...	...	...	...	...	...	...
July 22 ...	10,702	8.6	21	96	42,080	33·8	15	151	247	270	307	238	40·19 N.	69·4 W.	S. 71·22 E.	...	...	...	...
July 23 ...	12,250	8·68	21	100	47,120	33·0	15	161	261	308	335	282	41·27 N.	63·6 W.	S. 76·3 E.	...	...	...	...
July 24 ...	12,421	8·5	21	108	47,770	34·0	16	169	277	302	345	285	43·10 N.	57·7 W.	N. 68·59 E.	...	...	...	...
July 25 ...	12,583	9·0	21	113	49,010	34·71	$16\frac{1}{2}$	175	288	319	355	272	44·12 N.	50·7 W.	N. 76·37 E.	...	...	...	...
July 26 ...	12,655	9·0	21	114	48,680	34·4	16	173	287	320	351	278	45·47 N.	44·41 W.	N. ·70 E.	...	...	...	...
July 27 ...	10,948	8·0	21	102	47,140	33·31	16	162	264	284	337	284	47·33 N.	38·5 W.	N. ·38 E.	...	...	...	...
July 28 ...	12,227	8·7	21	106	47,390	33·7	16	167	273	310	341	288	49·29 N.	·32 W.	N. ·66 E.	...	...	...	...
July 29 ...	12,880	9·0	21	169	46,370	33·0	$15\frac{1}{2}$	162	271	320	331	288	51·10 N.	24·52 W.	N. ·69 E.	...	...	...	...
July 30 ...	13,059	9·25	21	107	47,440	33·57	16	170	277	329	338	250	51·34 N.	17·46 W.	N. 88·34 E.	...	...	...	...
July 31 ...	13,140	9·37	21	111	46,950	33·5	$15\frac{1}{2}$	171	282	332	339	270	51·34 N.	11·3 W.	N. 83·36 E.	...	...	...	...
Aug. 1 ...	12,844	9·14	21	111	45,800	33·0	16	168	279	319	336	270	Off Holyhead.		Various.	...	...	...	...
Aug. 2 ...	3,466	9·5	21	16	11,790	33·0	16	38	54	86	86	70	Steering by the land.			...	...	...	...
Total	139,175	9·22	21	1218	527,540	33·37	16	1902	3120	3499	3801	3075	...	...	...	...	...	...	...

Actual time of steaming from New York to Montauk, 8 hours. From Montauk to Bell Buoy, 10 days 15 hours 30 minutes. Total, 10 days 23 hours 30 minutes. Density of water in boilers, $1\frac{5}{8}$; vacuum in paddle engines, 26·5; vacuum in screw engines, 25·5; extreme diameter of paddle wheel, 50ft.; effective diameter 48·83ft. = 153·5ft. each revolution; pitch of screw, 44ft.; distance run per hour, 11·65 knots; immersion on leaving New York, 25ft. 9in. forward,—aft. 28ft.; ditto on arrival at Liverpool, 23ft. forward,—25ft. 9in. aft.; slip of paddle wheels, 13·8 per cent.; slip of screw, 23·6 per cent.; average daily consumption of coals by paddle engines, 110·72 tons; ditto by screw engines, 173 tons; total daily consumption of coals, 283·72 tons.

* For coaling furnace bars and getting up steam.

General Remarks.

July 22, at 12.15 noon, started engines ahead slow; 2.45 p.m., full speed; 10.45 p.m., stopped engines off Montauk Point, to discharge pilot; 11.10 p.m., full speed; light N.N.E. breeze; sea smooth.

July 23, light E.N.E. breeze; sea smooth.

July 24, light E.S.E. breeze; sea smooth.

July 25, light E. breeze; sea smooth.

July 26, dense fog; standing by engines; fresh E. breeze, and heavy sea running.

July 27, strong S.W. and W. gale; heavy sea running; fore topsail set.

July 28, fresh W. breeze; heavy sea running; ship rolling heavily; screw engines racing; fore topsail set.

July 29, fresh S.W. breeze, and heavy sea running.

July 30, fresh S.S.E. breeze, and heavy sea running.

July 31, fresh S.S.E. breeze, and heavy swell.

August 1, fresh S.E. breeze, and heavy swell.

August 2, at 3.20 p.m., stopped engines, to take pilot on board; 3.35, full speed; at 6 p.m., stopped engines off Bell Buoy, to wait for tide.

TABLE SHOWING THE QUANTITY OF HYPOCHLORITE OF LIME OR BLEACHING POWDER REQUIRED TO PRODUCE SOLUTIONS OF DIFFERENT DENSITIES, &c.

COMPILED BY

MR. T. W. KEATES, F.C.S.

The following Table shows the approximate quantity of Hypochlorite of Lime or Bleaching Powder per cent. or in lbs., &c., per gallon, required to make a clear bleaching liquid of a given strength.

The numbers in the two first columns are the mean of a great many actual weighings made upon the clear solution after the insoluble matter had completely subsided.

The numbers in the fifth column are obtained upon the assumption that 33·3 per cent. of chlorine represents the value of good commercial bleaching powder.

Bleaching Powder per Cent. by Weight.	Specific Gravity of the Solution.	Equivalent in Degrees of Twaddel.	Bleaching Powder in lbs., &c., per Gallon.			Chlorine per Cent. by Weight.
			lbs.	oz.	drms.	
20·0	1114·0	22·8	2	4	5	6·66
19·5	1111·1	22·2	2	2	11	6·50
19·0	1108·3	21·6	2	1	14	6·33
18·5	1105·4	21·0	2	1	8	6·16
18·0	1102·6	20·5	2	0	0	6·00
17·5	1099·7	19·9	1	14	11	5·83
17·0	1096·9	19·3	1	13	15	5·66
16·5	1094·0	18·8	1	12	12	5·50
16·0	1091·2	18·2	1	12	0	5·33
15·5	1088·3	17·6	1	11	3	5·16
15·0	1085·5	17·1	1	10	4	5·00
14·5	1082·6	16·5	1	9	2	4·83
14·0	1079·8	15·9	1	8	5	4·66
13·5	1076·9	15·3	1	7	8	4·50
13·0	1074·1	14·8	1	6	6	4·33
12·5	1071·2	14·2	1	5	7	4·16
12·0	1068·4	13·6	1	4	5	4·00
11·5	1065·5	13·1	1	3	8	3·83
11·0	1062·7	12·5	1	2	13	3·66
10·5	1059·8	11·9	1	1	12	[illegible]
10·0	1057·0	11·4	1	0	15	3·33
9·5	1054·1	10·8	1	0	4	3·16
9·0	1051·3	10·2	0	15	8	[illegible]
8·5	1048·4	9·6	0	14	0	2·83
8·0	1045·6	9·1	0	13	5	2·66
7·5	1042·7	8·5	0	12	13	2·50
7·0	1039·9	7·9	0	11	8	2·33
6·5	1037·0	7·4	0	11	0	2·16
6·0	1034·2	6·8	0	10	5	2·00
5·5	1031·3	6·2	0	9	2	1·83
5·0	1028·5	5·7	0	8	3	1·66
4·5	1025·6	5·1	0	7	7	[illegible]
4·0	1022·8	4·5	0	6	9	1·33
3·5	1019·9	3·9	0	5	13	1·16
3·0	1017·1	3·4	0	4	14	1·00
2·5	1014·2	2·8	0	4	0	0·83
2·0	1011·4	2·2	0	3	3	[illegible]
1·5	1008·5	1·7	0	2	6	[illegible]
1·0	1005·7	1·1	0	1	9	[illegible]

TABLE FOR FINDING THE DIAMETERS OF SHAFTS OF WROUGHT IRON.

(*Illustrated by Plate* No. 248.)

The want felt in the drawing offices of engineers and machinists, of a ready means of determining the diameter of shafts suitable for transmitting a given power, has often been stated to us; and having been recently requested to furnish information on this subject to several correspondents, we have much pleasure in being able to present our subscribers with the accompanying table, which has been obligingly furnished to us by Mr. W. Jackson, of the firm of Jackson and Watkins, of the Canal Iron Works, Millwall.

This table exhibits a set of curves giving the diameter of shafts, in inches, for engines of from 10 to 500 horse-power, the revolutions varying from 20 to 150. This table was computed from the formula—

$$D = \sqrt[3]{\frac{320 \text{ H.P.}}{n}}$$

D being the diameter of the shaft,
H.P. the horse-power,
n the number of revolutions per minute.

Example.—Required, the diameter for the driving shaft of an engine of 260 horse-power, making 30 revolutions per minute. By the table, D = 14 in. Intermediate powers or speeds may be ascertained by interpolation, for example, 250 H.P. at 30 revolutions = 13·8 in.; or 260 H.P. at 32 revolutions = 13·8 in.

INTERNATIONAL EXHIBITION, 1862.

Report by the Committee appointed at a General Meeting (held on the 18th day of June, 1863,) of the Medal-holders and Gentlemen interested in the awards of the International Exhibition, 1862, Alderman Copeland, M.P., *Chairman.*

A meeting of gentlemen to whom prize medals and certificates of honourable mention were awarded by the Commissioners of the Exhibition of 1862, was held at the rooms of the Society of Arts (by the kind permission of the Council of that body), on the 18th of June last; when a committee was appointed for the purpose of obtaining protection for the prize medallists against the unauthorised assumption of the medals and honourable mentions by persons to whom they had not been granted.

The meeting was called in consequence of a recent case, in which an application was made to the Court of Chancery for an injunction to restrain the piracy of the prize medals by a manufacturer who had not obtained any prize medal, nor exhibited at the Exhibition, but which application had failed, the Vice-Chancellor having decided that, in the existing law, the grant of a prize medal to one manufacturer or exhibitor created no right on his part to restrain any statement (fraudulent or otherwise) by another manufacturer of a similar article, to the effect that *he* had obtained a medal.

Your committee, after conferring with some members of the Society of Arts, obtained the necessary professional assistance, and caused a bill to be prepared, for the purpose of giving effect to the views of the meeting by whom they were appointed. This bill was drawn with the utmost possible care, with the assistance of gentlemen who had been professionally connected with the "Merchandise Marks Act" of last year, and was settled by two counsel who have made the Trade Marks and Copyright Acts a special study, and who are the authors of the most recent legal works on those subjects; and was afterwards submitted for the consideration and correction of a learned judge, who most kindly afforded to your committee the benefit of his great experience.

The Draft Bill so prepared was laid before the President of the Board of Trade, who, while expressing his desire to assist in promoting the object in view, hesitated to introduce any measure of the description contemplated, into the House of Commons, at so late a period of the Session.

It became necessary to apply to the Earl Granville for aid in this difficulty. Some discussion took place, and very earnest representations were made to his lordship of the great importance of the question involved, and the absolute necessity, if any benefit at all were to be derived from any legislative enactment, that the requisite measure should be passed in the Session which has just terminated. Earl Granville received the representatives of your body with the utmost kinduess and urbanity, and expressed his desire to assist the committee in the objects they had in view; but, after consultation with some other members of the Government, a doubt was expressed whether the bill, as prepared by your committee, was not likely to lead to a too lengthened discussion for so late a period of the Session.

The result was that a gentleman, officially connected with one of the departments of the Government, was instructed to prepare a short Government Bill, in lieu of that prepared by your committee, who were however consulted, and through their legal advisers made various suggestions on that bill, as at first framed. Some of these were adopted; as respects others, your committee were less fortunate.

The measure as introduced may have been deemed imperfect, but it was apparent that your committee's clearest possible duty was to aid, by every means in their power, the passing of that measure, even if needing amendment in a future Session, rather than allow Parliament to dissolve and the recess to pass, without any legislative enactmént being obtained, the result of which would have been that, before Parliament re-assembled, the continued piracies of Exhibition awards would have deprived them of value, in the hands of the real holders.

The measure so introduced has, with some trifling alterations, become law. Your committee feel confident that the evils complained of will be thereby checked, and that the holders of the awards have the strongest grounds for congratulation.

The measure was introduced, and read a first time, on the 20th July; read a second time, and committee dispensed with, on the 21st; amended, read a third time, and passed in the Lords; reprinted and introduced in the Commons, and read a first time there, on the 23rd; read a second time, passed through Committee, and reported, on the 24th; read a third time and passed, after a long debate, on the 27th; and received the Royal assent on the 28th, under the title, "The Exhibitions Medals Act, 1863."

This result was only arrived at by dint of very great exertion on the part of those who took any active part, either in the proceedings of the committee or the carriage of the measure.

The Marquis of Clanricarde kindly undertook, at the shortest possible notice, to take charge of the bill in the House of Lords; and by his clear and admirable statement of the objects and necessity for the measure, secured its unanimous adoption by that House.

A very large number of members, on both sides of the House of Commons, gave their aid towards the passing of the measure, and the thanks of the medal-holders are most justly their due. It is difficult to distinguish where so many are entitled to acknowledgments, but it will probably be felt by all, that the President of the Board of Trade, who took charge of the measure in the House of Commons, has added another to the many grounds on which he was already entitled to the thanks of the mercantile community.

Your committee applied to, and obtained the aid of, "The Mercantile Law Amendment Society," and through them the concurrence of the various Chambers of Commerce in the kingdom, and it is in a main degree to the great influence and established position of utility of the Mercantile Law Amendment Society that the success attained may be attributed.

It cannot but be felt that every medal-holder will derive benefit from the act that has been obtained; and that the commercial value of the awards of the Commissioners of the Exhibitions of 1851 and 1862, both at home and abroad, has been greatly enhanced by the legislative protection secured.

Of course the obtaining of an important act (especially when carried through the Legislature with such unexampled speed as in the present case) must be attended with considerable expense. It was necessary, to attain success, that individual members of the committee should take upon themselves not only more than their proportion of the labour, but the whole responsibility for the expenses incurred; and your committee confidently rely on those who have received awards for subscriptions to defray the cost thus incurred in their service.

It is not proposed that the foreign exhibitors should be asked to contribute at all. It is to the defect of the English law, as it existed at the time the Exhibitions were held, that the evils complained of have been attributable. This is a circumstance as to which the English exhibitors might have informed themselves, but for which the foreign exhibitors must have been wholly unprepared; and they cannot properly be asked to aid towards the necessary amendment of a law to which they are strangers.

A large number of the medal-holders have expressed their strong feeling of the importance of the present committee continuing organised for a time, to protect the interests of their fellow-medallists, and probably to promote an Amendment Act in the coming Session, or to watch the Amendment Bill which the President of the Board of Trade has promised to introduce. Your committee are unwilling to abandon the cause which they have once embraced, and have consented to continue their functions.

Your committee would request information of every case that may come to the knowledge of any medal-holder, in which any person falsely represents that he has obtained either a medal or honourable mention; and any suggestion as to measures to be adopted towards giving effect to the act already obtained, and stopping the fraudulent dealings to which it is intended to apply.

Except in so far as any such further proceedings may be concerned, your committee's task has been performed. They have obtained the legislative protection which they were desired to seek; and they trust it will be felt by the whole of those whose interests were confided to their care, not alone that every exertion has been used for obtaining the result desired, but that there is every ground for mutual congratulations, between the committee and their constituents, on the unexampled rapidity with which this result has been arrived at, and the success with which their exertions on your behalf have been crowned.

(By order) Edmund Johnson,
London, August 15, 1863. Hon. Secretary.

Copy of "The Exhibition Medals Act," 1863.

Whereas it is expedient to prevent false representations with respect to grants of medals and certificates by the Commissioners for the Exhibition of 1851 and the Commissioners for the Exhibition of 1862: Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the lords spiritual and temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows:—

I. If any trader commits any of the offences following, that is to say,—1. Falsely represents that he has obtained a medal or certificate from the Exhibition Commissioners in respect of any article or process for which a medal or certificate has been awarded by the Commissioners; 2. Falsely represents (knowing such representation to be false) that any other trader has

obtained a medal or certificate from the Exhibition Commissioners; 3. Falsely represents (knowing such representation to be false) that any article sold or exposed for sale has been made by, or by any process invented by, a person who has obtained in respect of such article or process a medal or certificate from the Exhibition Commissioners, he shall incur the following penalties; that is to say, 1. For the first offence he shall forfeit to her Majesty a sum not exceeding five pounds. 2. For any subsequent offence he shall forfeit to her Majesty a sum not exceeding twenty pounds, or be imprisoned for a period not exceeding six months.

II. In proceedings under this Act it shall not be necessary to prove that any person has sustained damage by the false representations of the defendant. It shall not be necessary in any proceedings under this Act to set out any copy or fac-simile of any medal or certificate.

III. For the purposes of this Act, "the Exhibition Commissioners" shall mean the Commissioners for the Exhibition of 1851 and the Commissioners for the Exhibition of 1862. The term "defendant" shall mean any person against whom proceedings may be taken under this Act.

IV. Offences under this Act may be prosecuted summarily in England and Ireland before two justices; as to England, in manner directed by an Act passed in the session holden in the eleventh and twelfth years of the reign of her Majesty Queen Victoria, c. 43, intituled "An Act to facilitate the Performance of the Duties of Justices of the Peace out of Sessions within England and Wales with respect to summary Convictions and Orders, or any Act amending the same; as to Ireland, in manner directed by the Act passed in the session holden in the fourteenth and fifteenth years of the reign of her Majesty Queen Victoria, intituled "An Act to Consolidate and amend the Acts regulating the Proceedings in Petty Sessions and the Duties of Justices of the Peace out of Quarter Sessions in Ireland, or any Act amending the same. In Scotland, an offence against this Act may be prosecuted summarily at the instance of the Procurator Fiscal before any sheriff and sheriff substitute, or before any two justices of the county, or before the magistrates or any police magistrate of the burgh in which the offence was committed.

V. No provision of this Act shall take away, diminish, or prejudicially affect any suit, process, proceeding, right, or remedy which any person may be entitled to at law, in equity, or otherwise; nor exempt or excuse any person from answering or making discovery upon examination as a witness, or upon interrogatories or otherwise, in any suit or other civil proceeding: Provided always, that no evidence, statement, or discovery, which any person shall be compelled to give or make shall be admissible in evidence against such person in support of any indictment for a misdemeanour at common law or otherwise, or of any proceeding under the provisions of this Act.

VI. This Act may be cited for all purposes as "the Exhibition Medals Act, 1863."

TRIAL OF THE "CONSTANCE."

In THE ARTIZAN of last month we gave some further particulars as to the dimensions of this vessel and her machinery, as also a notice of a trial trip which she made on the 6th July, when it will be remembered from the overheating of the bearings, the result was not very satisfactory. Since that time the necessary adjustments and alterations having been made, the *Constance* went out again on trial on the 10th ult. The chief particulars of her performance under trial are as follows:—Draught of water, forward, 17ft. 1in.; aft, 20ft. 10in.; propeller, diameter 18ft.; pitch, 25ft.; upper edge 4in. out of water. Steam in boilers, 32·5lbs. per square inch; mean pressure in high pressure cylinders, 19·54; ditto in low pressure cylinders, 3·96; indicated horse-power, 2017; mean pressure at half-boiler power in high pressure cylinders, 14·955; in low pressure cylinders, 2·34; indicated horse-power, 1190. Vacuum in condensers, 28in.; barometer, 30.2; maximum temperature in stoke-hole, 104°; minimum in ditto, 86°; maximum temperature in engine room, 71°; minimum in ditto, 72°; temperature on deck, 68°.

No. of runs.	Revolutions of Engines.	Time.	Speed.	1st Mean.	2nd Means.	True Mean.
1	55½	4′ 54″	12·215			
2	56¼	4 48	12·500	12·372		
3	53	4 58	12·081	12·291	12·331	12·301
4	55	5 2	11·921	12·001	12·146	
5	55½	4 42	12·766	12·343	12·172	
6	55	4 42	12·766	12·766	12·555	
			At Half Boiler Power.			
1	43	5′ 43″	10·496			
2	47	6 8	9·783	10·139		10·573
3	48	5 12	11·538	10·661	10·400	
4	47	5 55	10·141	10·834	10·747	

It will be seen from these particulars that the results were much more satisfactory than those obtained on the previous trial, and doubtless still better results may be expected when the various parts of her machinery have been brought into proper working order.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The annual meeting of the British Association commenced at Newcastle-on-Tyne on the 26th ult. The following is an abstract of the address of the President:—

The President, Sir William Armstrong, in opening his address, stated that he deemed it the greatest honour of his life that he was called upon to assume the office of President, and adverted to the gratifying reception which the British Association had met with on their former visit to this region of mining and manufacturing industry. A quarter of a century had elapsed since the Association assembled in this town, and in no former period of equal duration had so great a progress been made in physical knowledge. In mechanical science, and especially in those branches of it which are concerned in the application of steam power to effect interchange between distant communities, the progress made since 1838 has no parallel in history. The railway system was then in its infancy, and the great problem of Transatlantic steam navigation had only received its complete solution in the preceding year. Since that time railways have extended to every continent, and steamships have covered the ocean. The history of railways shows what grand results may have their origin in small beginnings. When coal was first conveyed in this neighbourhood from the pit to the shipping-place on the Tyne, the pack-horse was in use. As soon as roads suitable for wheeled carriages were formed carts were introduced. The next improvement consisted in laying wooden bars or rails for the wheels of the cart to run upon, and this was followed by the substitution of the four-wheeled waggon for the two-wheeled cart. By this further application of mechanical principles the original horseload of 3cwt. was augmented to 42cwt. The next step in the progress of railways was the attachment of slips of iron to the wooden rails. Then came the iron tramways, consisting of cast-iron bars of an angular section; in this arrangement the upright flange of the bar acted as a guide to keep the wheel on the track. The next advance was an important one, and consisted in transferring the guiding flange from the rail to the wheel; this improvement enabled cast-iron edge rails to be used. Finally, in 1820, after a lapse of about 200 years from the first employment of wooden bars, wrought iron rails, rolled in long lengths, and of suitable section, were made in this neighbourhood, and eventually superseded all other forms of railway. Last of all came the locomotive engine, that crowning achievement of mechanical science, which enables us to convey a load of 200 tons at a cost of fuel scarcely exceeding that of the corn and hay which the original packhorse consumed in conveying its load of 3cwt. an equal distance. It was chiefly in this locality that the railway system was thus reared from earliest infancy to full maturity, and among the many names associated with its growth that of George Stephenson stands pre-eminent. As in the vegetable kingdom fit conditions of soil and climate quickly cause the appearance of suitable plants, so in the intellectual world fitness of time and circumstances promptly calls forth appropriate devices. The seeds of invention exist, as it were, in the air, ready to germinate whenever suitable conditions arise, and no legislative interference is needed to insure their growth in proper season. The coalfields of this district, so intimately connected with the railway system, both in its origin and maintenance, will doubtless receive much attention from the Association at their present meeting. After dwelling upon the origin of the coal deposits, the President stated that the quantity of that invaluable mineral which has been stored up throughout the globe for our benefit is sufficient (if used discreetly), to serve the purposes of the human race for many thousands of years. In fact, the entire quantity of coal may be considered as practically inexhaustible. Estimates have been made at various periods of the time which would be required to produce complete exhaustion of all the accessible coal in the British islands. These estimates are extremely discordant; but the discrepancies arise, not from any important disagreement as to the available quantity of coal, but from the enormous difference in the rate of consumption at the various dates when the estimates were made, and also from the different views which have been entertained as to the probable increase of consumption in future years. The quantity of coal yearly worked from British mines has been almost trebled during the last 21 years, and has probably increased tenfold since the commencement of the present century; but as this increase has taken place pending the introduction of steam navigation and railway transit, and under exceptional conditions of manufacturing development, it would be too much to assume that it will continue to advance with equal rapidity. By combining the known thickness of the various workable seams of coal, and computing the area of the surface under which they lie, it is easy to arrive at an estimate of the total quantity comprised in our coal-bearing strata. Assuming 4000ft. as the greatest depth at which it will ever be possible to carry on mining operations, and rejecting all seams of less than 2ft. in thickness, the entire quantity of available coal existing in these islands has been calculated to amount to about 80,000 millions of tons, which, at the present rate of consumption, would be exhausted in 930 years, but

with a continued yearly increase of $2\frac{3}{4}$ millions of tons, would only last 212 years. It is clear that long before complete exhaustion takes place England will have ceased to be a coal-producing country on an extensive scale. The question is, not how long our coal will endure before absolute exhaustion is effected, but how long will those particular coal-seams last which yield coal of a quality and at a price to enable this country to maintain her present supremacy in manufacturing industry. Were we reaping the full advantage of all the coal we burnt no objection, could be made to the largeness of the quantity; but we are using it wastefully and extravagantly in all its applications. It is probable that fully one-fourth of the entire quantity of coal raised from our mines is used in the production of heat for motive power; but, much as we are in the habit of admiring the powers of the steam-engine, our present knowledge of the mechanical energy of heat shows that we realise in that engine only a small part of the thermic effect of the fuel. That a pound of coal should, in our best engines, produce an effect equal to raising a weight of a million pounds a foot high is a result which bears the character of the marvellous, and seems to defy all further improvement. Yet the investigations of recent years have demonstrated the fact that the mechanical energy resident in a pound of coal, and liberated by its combustion, is capable of raising to the same height ten times that weight. The average quantity of coal which we expend in realising a given effect, by means of the steam-engine, is about 30 times greater than would be requisite with an absolutely perfect heat-engine. The causes which render the application of heat so un-economic in the steam-engine have been brought to light by the discovery of the dynamical theory of heat; and it now remains for mechanicians, guided by the light they have thus received, to devise improved practical methods of converting the heat of combustion into available power. Engines in which the motive power is excited by the communication of heat to fluids already existing in the aëriform condition, as in those of Stirling, Ericsson, and Siemens, promise to afford results greatly superior to those obtained from the steam-engine. It is a common observation that before coal is exhausted some other motive agent will be discovered to take its place, and electricity is generally cited as the coming power. Electricity, like heat, may be converted into motion, and both theory and practice have demonstrated that its mechanical application does not involve so much waste of power as takes place in a steam-engine; but, whether we use heat or electricity as a motive power, we must equally depend upon chymical affinity as the source of supply. The act of uniting to form a chymical product liberates an energy which assumes the form of heat or electricity, from either of which states it is convertible into mechanical effect. In contemplating, therefore, the application of electricity as a motive power we must bear in mind that we shall still require to effect chymical combinations, and in so doing to consume materials. But where are we to find materials so economical for this purpose as the coal we derive from the earth, and the oxygen we obtain from the air? The latter costs absolutely nothing; and every pound of coal which in the act of combustion enters into chymical combustion renders more than $2\frac{1}{2}$lb. of oxygen available for power. We cannot look to water as a practicable source of oxygen, for there it exists in the combined state, requiring expenditure of chymical energy for its separation of hydrogen. It is in the atmosphere alone that it can be found in that free state in which we require it, and there does not appear to be the remotest chance, in an economic point of view, of being able to dispense with the oxygen of the air as a source either of thermodynamic or electrodynamic effect. But to use this oxygen we must consume some oxidisable substance, and coal is the cheapest we can produce. The President, in respect to the use of falling water as a motive power, stated that the hydraulic capabilities of our streams sank into insignificance when compared with those of Alpine and other regions,—referred to Niagara, which expends sufficient power to carry on the whole manufacturing operations of mankind,—and stated that industrial populations had scarcely yet extended to those regions which afford this profusion of motive power; but we may anticipate the time when these natural falls will be brought into useful operation. He stated that coal is also extensively used for the kindred purpose of relaxing those cohesive forces which resist our efforts to give new forms and conditions to solid substances. In these applications, which are generally of a metallurgical nature, the same wasteful expenditure of fuel is everywhere observable. In an ordinary furnace employed to fuse or soften any solid substance, it is the excess of the heat of combustion over that of the body heated which alone is rendered available for the purpose intended; the rest of the heat, which in many instances constitutes by far the greater proportion of the whole, is allowed to escape uselessly into the chimney. The combustion also in common furnaces is so imperfect that clouds of powdered carbon, in the form of smoke, envelope our manufacturing towns, and gases, which ought to be completely oxygenized in the fire, pass into the air with two-thirds of their heating power undeveloped. Some remedy for this state of things we may hope is at hand in the gas regenerating furnaces recently intraduced by Mr. Siemens. With regard to smoke, which is at once a waste and a nuisance, the President stated that he had taken part with Dr. Richardson and Mr. Longridge in a series of experiments made in this neighbourhood in the years 1857-58 for the purpose of testing the practicability of preventing smoke in the combustion of bituminous coal in steam-engine boilers, and stated with perfect confidence that, so far as the raising of steam is concerned, the production of smoke is quite unnecessary and inexcusable. After adverting to the wasteful use of coal for domestic purposes, the President spoke of the danger attending colliery operations, and was of opinion that, though the Davy lamp was a great boon to the miner, it led him into more dangerous workings, and, as far as the miner was concerned, neutralised its effects. The only gleam of amelioration, he remarked, is in the fact that the loss of life in relation to the quantity of coal worked is on the decrease, taken as a percentage on the number of miners employed. The increase of the earth's temperature as we descend below the surface is a subject which has been discussed at previous meetings of the British Association. It possesses great scientific interest as affecting the computed thickness of the crust which covers the molten mass, assumed to constitute the interior portions of the earth, and it is also of great practical importance, as determining the depth at which it would be possible to pursue the working of coal and other minerals. At the last meeting of the British Association in this town the importance of establishing an office for mining records was brought under notice of the Council by Mr. Sopwith, and measures were taken which resulted in the formation of the present Mining Records Office. The British Association may congratulate itself upon having thus been instrumental in establishing an office in which plans of abandoned mines are preserved for the information of those who at a future period may be disposed to incur the expense of again bringing those mines into operation. Before dismissing this subject of coal it may be proper to notice the recent discovery by Berthelot of a new form of carburetted hydrogen possessing twice the illuminating power of ordinary coal-gas. Berthelot succeeded in procuring this gas by passing hydrogen between the carbon electrodes of a powerful battery. Dr. Odling has since shown that the same gas may be produced by mixing carbonic oxide with an equal volume of light carburetted hydrogen and exposing the mixture in a porcelain tube to an intense heat. Still more recently, Mr. Siemens has detected the same gas in the highly-heated regenerators of his furnaces, and there is now every reason to believe that the new gas will become practically available for illuminating purposes. Of all the results which science has produced within the last few years, none has been more unexpected than that by which we are able to test the materials of which the sun is made, and prove their identity, in part at least, with those of our planet. The spectrum experiments of Bunsen and Kirchoff have not only shown all this, but they have also corroborated previous conjectures as to the luminous envelope of the sun. The President then went into an elaborate elucidation of the theory of the transmission of heat from the sun to the earth, and the dynamical theory of heat, referring to the labours of Naysmith, Mayer, Joule, Dr. Young, Thompson, and Rankine, and the earlier theorists, Lord Bacon and Aristotle. He then referred to the science of gunnery, as being intimately connected with the dynamical theory of heat. When gunpowder is exploded in a cannon, the immediate effect of the affinities by which the materials of the powder are caused to enter into new combinations, is to liberate a force which first appears as heat, and then takes the form of mechanical power communicated in part to the shot and in part to the products of explosion which are also propelled from the gun. The mechanical force of the shot is reconverted into heat when the motion is arrested by striking an object, and this heat is divided between the shot and the object struck, in the proportion of the work done or damage inflicted upon each. While speaking of the subject of gunnery, the President paid a passing tribute of praise to that beautiful instrument invented and perfected by Major Navez, of the Belgian Artillery, for determining, by means of electro-magnetism, the velocity of projectiles. This instrument has been of great value in recent investigations, and there are questions affecting projectiles which we can only hope to solve by its assistance. Experiments are still required to clear up several apparently anomalous effects in gunnery, and to determine the conditions most conducive to efficiency, both as regards attack and defence. It is gratifying to see our Government acting in accordance with the enlightened principles of the age, by carrying on scientific experiments to arrive at knowledge, which, in the arts of war, as well as of those of peace, is proverbially recognised as the true source of human power. Professor Tyndall's recent discoveries respecting the absorption and radiation of heat by vapours and permanent gases, constitute important additions to our knowledge. The extreme delicacy of his experiments and the remarkable distinctness of their results render them beautiful examples of physical research. They are of great value as affording further illustrations of the vibratory actions in matter which constitute heat; but it is in connexion with the science of meteorology that they chiefly command our attention. Few sciences have more practical value than meteorology, and there are few of which we

as yet know so little. Nothing would contribute more to the saving of life and property, and to augmenting the general wealth of the world, than the ability to foresee with certainty impending changes of the weather. At present our means of doing so are exceedingly imperfect, but, such as they are, they have been employed with considerable effect by Admiral Fitzroy, in warning mariners of the probable approach of storms. We hope that so good an object will be effected with more unvarying success when we attain a better knowledge of the causes by which wind and rain, heat and cold are determined. The balloon explorations, conducted with so much intrepidity by Mr. Glaisher, under the auspices of the British Association, may perhaps in some degree assist in enlightening us upon these important subjects. We have learnt from Mr. Glaisher's observations that the decrease of temperature with elevation does not follow the law previously assumed of 1 deg. in 300ft., and that in fact it follows no definite law at all. Mr. Glaisher appears also to have ascertained the interesting fact that rain is only precipitated when cloud exists in a double layer. Raindrops, he has found, diminish in size with elevation, merging into wet mist, and ultimately into dry fog. Mr. Glaisher met with snow for a mile in thickness below rain, which is at variance with our preconceived ideas. He has also rendered good service by testing the efficiency of various instruments at heights which cannot be visited without personal danger. The facility now given to the transmission of intelligence and the interchange of thought is one of the most remarkable features of the present age. Cheap and rapid postage to all parts of the world; paper and printing reduced to the lowest possible cost; electric telegraphs between nation and nation, town and town, and now even (thanks to the beautiful inventions of Professor Wheatstone), between house and house—all contribute to aid that commerce of ideas by which wealth and knowledge are augmented. But while so much facility is given to mental communication by new measures and new inventions, the fundamental art of expressing thought by written symbols remains as imperfect now as it has been for centuries past. It seems strange that while we actually possess a system of shorthand by which words can be recorded as rapidly as they can be spoken, we should persist in writing a slow and laborious longhand. It is intelligible that grown-up persons who have acquired the present conventional art of writing should be reluctant to incur the labour of mastering a better system; but there can be no reason why the rising generation should not be instructed in a method of writing more in accordance with the activity of mind which now prevails. Even without going so far as to adopt for ordinary use a complete system of stenography, which it is not easy to acquire, we might greatly abridge the time and labour of writing by the recognition of a few simple signs to express the syllables which are of most frequent occurrence in our language. Another subject of a social character which demands our consideration is the much-debated question of weights and measures. Whatever difference of opinion there may be as to the comparative merits of decimal and duodecimal division, there can, at all events, be none as to the importance of assimilating the systems of measurement in different countries. Science suffers by want of uniformity, because valuable observations made in one country are in a great measure lost to another from the labour required to convert a series of quantities into new denominations. International commerce is also impeded by the same cause, which is productive of constant inconvenience and frequent mistakes. The President could speak from personal experience of the superiority of decimal measurement in all cases where accuracy is required in mechanical construction. In the Elswick Works, as well as in other large establishments of the same description, the inch is adopted as the unit, and all fractional parts are expressed in decimals. No difficulty has been experienced in habituating the workmen to the use of this method, and it has greatly contributed to precision of workmanship. The inch, however, is too small a unit, and it would be advantageous to substitute the metre, if general concurrence could be obtained. As to our thermometric scale, it was originally founded in error; it is also most inconvenient in division, and ought at once to be abandoned in favour of the Centigrade scale. The recognition of the metric system and of the Centigrade scale by the numerous men of science composing the British Association would be a most important step towards effecting that universal adoption of the French standards in this country which sooner or later will inevitable take place; and the Association, in its collective capacity, might take the lead in this good work, by excluding in futuro all other standards from their published proceedings. The recent discovery of the source of the Nile by Captains Speke and Grant has solved a problem in geography which has been a subject of speculation from the earliest ages. It is an honour to England that this interesting discovery has been made by two of her sons; and the British Association, which is accustomed to value every addition to knowledge for its own sake, will at once appreciate the importance of the discovery, and the courage and devotion by which it has been accomplished. The science of organic life has of late years been making great and rapid strides, and it is gratifying to observe that researches both in zoology and botany are characterised in the present day by great accuracy and elaboration. Investigations patiently conducted upon true inductive principles cannot fail eventually to elicit the hidden laws which govern the animated world. The remarkable work of Mr. Darwin, promulgating the doctrine of natural selection, has produced a profound sensation. The novelty of this ingenious theory, the eminence of its author, and his masterly treatment of the subject, have, perhaps, combined to excite more enthusiasm in its favour than is consistent with that dispassionate spirit which it is so necessary to preserve in the pursuit of truth. The President said he would not run the risk of wearying the assembly by extending his remarks to other branches of science; and in conclusion expressed a hope that, when the time again comes round to receive the British Association in this town, its members will find the interval to have been as fruitful as the corresponding period on which they now looked back. The tendency of progress is to quicken progress, because every acquisition in science is so much vantage ground for fresh attainment. We may expect, therefore, to increase our speed as we struggle forward; but, however high we climb in the pursuit of knowledge, we shall still see heights above us; and the more we extend our view the more couscious we shall be of the immensity which lies beyond.

At the conclusion of this address, which occupied little more than an hour in its delivery, the applause of the audience broke forth, and continued almost uninterruptedly for some minutes.

ABSTRACT OF AN INVESTIGATION ON PLANE WATER-LINES.

By W. J. Macquorn Rankine, C.E., LL.D., F.R.SS., L. & E. &c.

1. This paper contains an abstract of a mathematical investigation, which has been communicated in detail to the Royal Society. By the term "Plane Water-Line" is meant one of those curves which a particle of a liquid describes in flowing past a solid body, when such flow takes place in plane layers. Such curves are suitable for the water-lines of a ship; for during the motion of a well-formed ship, the vertical displacements of the particles of water are small compared with the dimensions of the ship; so that the assumption that the flow takes place in plane layers, though not absolutely true, is sufficiently near the truth for practical purposes.

2. The author refers to the researches of Professor Stokes (*Cambr, Trans.* 1842,) "on the Steady Motion of an Incompressible Fluid," and of Professor William Thanson, (made in 1858, but not yet published.) as containing the demonstration of the general principles of the flow of a liquid past a solid body.

3. Every figure of a solid past which a liquid is capable of flowing smoothly, generates an endless series of water-lines, which become sharper in their forms as they are more distant from the primitive water-line of the solid. The only exact water-lines, whose forms have hitherto been completely investigated, are those generated by the cylinder, in two dimensions, and by the sphere, in three dimensions. In addition to what is already known of those lines, the author points out, that when a cylinder moves through still water, the orbit of each particle of water is one loop of an elastic curve.

4. The profiles of waves have been used with success in practice as water-lines for ships, first by Mr. Scott Russell (for the explanation of whose system the author refers to the Transactions of the Institution of Naval Architects for 1860-1-2), and afterwards by others. As to the frictional resistance of vessels having such lines, the author refers to his own papers; one read to the British Association in 1861, and printed in various engineering journals, and another read to the Royal Society in 1862, and printed in the Philosophical Transactions.

5. The author proceeds to investigate and explain the properties of a class of water-lines comprising an endless variety of forms and proportions. In each series of such lines, the primitive water-line is a particular sort of oval, characterized by this property; that the ordinate at any point of the oval is proportional to the angle between two lines drawn from that point to two foci. (In the Fig., L B represents a quadrant of such an oval; O being its centre, and A one of the foci. The other focus is at an equal distance to the other side of the centre.) Ovals of this class differ from ellipses, in being considerably fuller at the ends, and flatter at the sides.

6. The length of the oval may bear any proportion to its breadth, from equality (when the oval becomes a circle) to infinity. (In the Fig., the length O L is to the breadth O B, nearly as 17 : 6).

7. Each oval generates an endless series of water-lines, which become sharper in figure as they are further from the oval. In each of those derived lines, the excess of the ordinate at a given point above a certain minimum value, is proportional to the angle between a pair of lines drawn from that point to the two foci.

8. There is thus an endless series of ovals, each generating an endless series of water-lines; and amongst those figures, a continuous or "fair" curve can always be found, combining any proportion of length to breadth

from equality to infinity, with any degree of fullness or fineness of entrance, from absolute bluffness to a knife-edge.

9. The lines thus obtained present striking likenesses to those at which naval architects have arrived through practical experience; and every successful model in existing vessels can be closely imitated by means of them, from a Dutch galliot to a racing boat.

10. Any series of water-lines, including the primitive oval, are easily and quickly constructed with the ruler and compasses, as follows:—Parallel to the longitudinal axis O X, draw a series of straight lines at equal distances apart. Through the foci draw a series of circular arcs AC_1, AC_2, &c., so as to contain a series of angles found by dividing those distances by

$$\frac{OL^2-OA^2}{2\,OA}$$

Each of those circular arcs indicates the direction of motion, in still water, of each of the particles that it traverses. Then through the angles of the network formed by the straight lines and circular arcs, draw a series of curves; these will be the required water-lines. The centre of curvature of the oval at L is the focus A.

11. The following curves, traversing certain important points in the water-lines, are exactly similar for all water-lines of this class, and are easily and quickly constructed with the compasses.

LM is a hyperbola, having a pair of asymptotes crossing the axes at O at angles of 45°. It traverses all the points at which the motion of the particles, in still water, is at right angles to the water-lines.

LQN, and LP, are the two branches of a curve of the fourth order, having a pair of asymptotes which traverse O, making angles of 30° with OX. A straight line joining L and P makes an angle of 30° with LO. The two branches cross the axis OX at L, making angles of 45°. The branch LQN traverses a series of points at each of which the velocity of gliding of the particles of water along the water-line is less than at any other point on the same water-line. The branch LP traverses a series of points, at each of which the velocity of gliding is greater than at any other point on the same water-line.

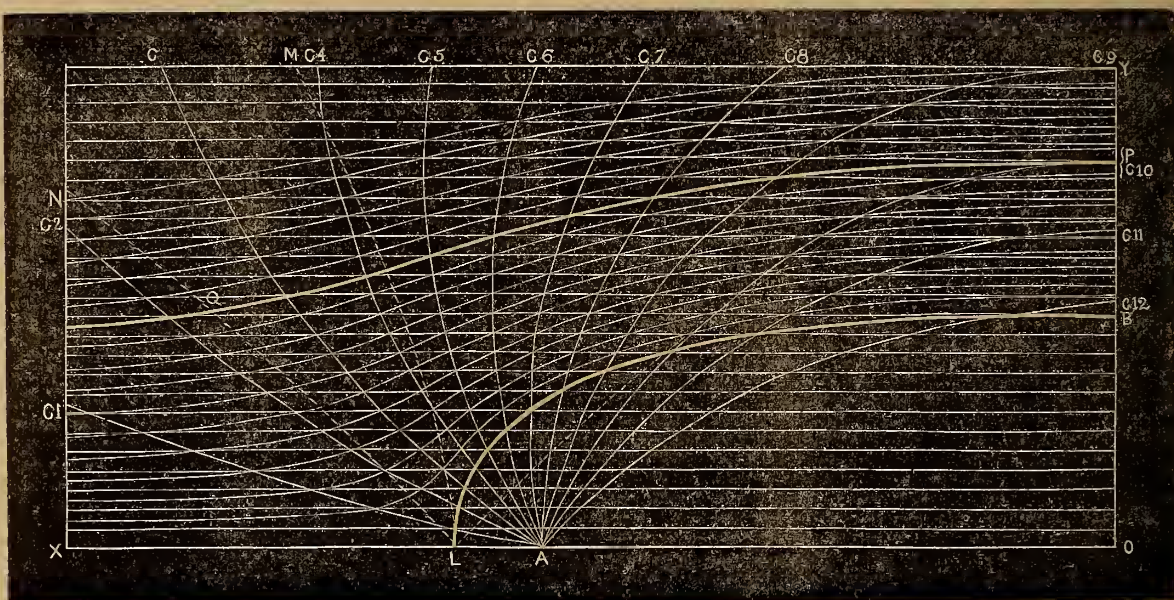
12. The axis OY, from B to P, traverses a series of points of minimum velocity of gliding; from P onwards, it traverses a series of points of maximum velocity of gliding.

13. Every water-line, complete from bow to stern, which passes within the point P, has three points of minimum and two of maximum velocity of gliding; while every water-line which passes through or beyond P, has only two points of minimum and one of maximum velocity of gliding. Hence the latter class of lines cause less commotion in the water than the former.

14. On the water-line PQ, which traverses the point P itself, the velocity of gliding changes more gradually than on any other water-line having the same proportion of length to breadth. Water-lines possessing this character can be constructed, with any proportion of length to breadth, from $\sqrt{3}$ (which gives an oval through L and P) to infinity. The finer of those lines are found to be nearly approximated to by wave-lines; but are less hollow at the bow than wave-lines are.

15. The author shows how horizontal water-lines at the bow, drawn according to this system, may be combined with vertical plane lines of motion for the water at the stern, if desired by the naval architects.

16. In this, as in every system of water-lines, a certain relation (according to a principle first pointed out by Mr. Scott Russell) must be preserved between the form and dimensions of the bow and the maximum speed of the ship, in order that the appreciable resistance may be wholly frictional, and proportional to the square of the velocity, (as the experimental researches of Mr. W. R. Napier and the author have shown it to be in well-formed ships,) and may not be augmented by terms increasing as the fourth and higher powers of the velocity, through the action of vertical disturbances of the water.



ON THE PROPORTIONS OF SHIPS OF LEAST SKIN-RESISTANCE FOR A GIVEN SPEED AND DISPLACEMENT.

By W. J. Macquorn Rankine, C.E., LL.D., &c., &c.

The author referred to a previous paper which he had read to the British Association in 1861, in which he had stated the results of a theoretical investigation of the "skin resistance" of ships, and verified those results by a comparison with those of experiment. In the course of that paper he had stated, that the theory gives, for the proportion of length to breadth which produces least skin-resistance with a given displacement and speed, that of *seven* to *one*, nearly.

This is the case *when the figures and proportions of the cross-sections are given*, so that the draught of water bears a fixed proportion to the breadth. But *when the draught of water has a fixed absolute value*, the theory gives a somewhat different result; for the proportion of length to breadth which produces the least skin-resistance is found to increase as the draught of water becomes shallower.

In the following table of examples L denotes the length, B the extreme breadth, H the draught of water, and the ratio $\sqrt{LB} \div H$, which is the argument of the table, is computed as follows:—

$$\frac{\sqrt{LB}}{H} = \sqrt{\left\{\frac{\text{Displacement in cubic feet}}{H^3 \times \text{co-efficient of fineness}}\right\}}$$

In the vessels to which these calculations are applicable, the cross sections are supposed to be nearly rectangular, and the "co-efficient of fineness" is in general between 0·55 and 0·65.

Example No.	I.	II.	III.	IV.	V.	VI.
$\frac{\sqrt{LB}}{H}$ =	5·2	9·9	15·6	22·5	30·7	40·2
$\frac{L}{B}$ =	7	8	9	10	11	12
$\frac{B}{H}$ =	2	3·5	5·2	7·1	9·3	11·6

The general agreement of those results with successful practice in ship-building is obvious.

THE ROYAL SOCIETY.

ON THE MOLECULAR MOBILITY OF GASES.

By Thomas Graham, F.R.S., Master of the Mint.

The molecular mobility of gases is here considered in reference chiefly to the passage of gases, under pressure, through a thin porous plate or septum, and to the partial separation of mixed gases which can be effected, as will be shown, by such means. The investigation arose out of a renewed and somewhat protracted inquiry regarding the diffusion of gases (depending upon the same molecular mobility), and has afforded certain new results which may prove to be of interest in a theoretical as well as in a practical point of view.

In the diffusiometer, as first constructed, a plain cylindrical glass tube, rather less than an inch in diameter and about ten inches in length, was simply closed at one end by a porous plate of plaster of Paris, about one-third of an inch in thickness, and thus converted into a gas receiver.* A superior material for the porous plate is now found in the artificially compressed graphite of Mr. Brockedon, of the quality used for making writing-pencils. This material is sold in London in small cubic masses about 2 inches square. A cube may easily be cut into slices of a millimetre or two in thickness by means of a saw of steel spring. By rubbing the surface of the slice without wetting it upon a flat sand-stone, the thickness may be further reduced to about one-half of a millemetre. A circular disk of this graphite, which is like a wafer in thickness, but possesses considerable tenacity, is attached by resinous cement to one end of the glass tube above described, so as to close it and form a diffusiometer. The tube is filled with hydrogen gas over a mercurial trough, the porosity of the graphite plate being counteracted for the time by covering it tightly with a thin sheet of gutta percha. On afterwards removing the latter, gaseous diffusion immediately takes place through the pores of the graphite. The whole hydrogen will leave the tube in forty minutes or an hour, and is replaced by a much smaller proportion of atmospheric air (about one-fourth), as is to be expected from the law of the diffusion of gases. During the process, the mercury will rise in the tube, if allowed, forming a column of several inches in height—a fact which illustrates strikingly the intensity of the force with which the interpenetration of different gases is effected. The native or mineral graphite is of a lamellar structure, and appears to have little or no porosity. It cannot be substituted for the artificial graphite as a diffusion-septum. Unglazed earthenware comes next in value to graphite for this purpose.

The pores of artificial graphite appear to be really so minute, that a gas *in mass* cannot penetrate the plate at all. It seems to be molecules only which can pass; and these may be supposed to pass wholly unimpeded by friction, for the smallest pores that can be imagined to exist in the graphite must be tunnels in magnitude to the ultimate atoms of a gaseous body. The sole motive agency appears to be that intestine movement of molecules which is now generally recognised as an essential property of the gaseous condition of matter.

According to the physical hypothesis now generally received†, a gas is represented as consisting of solid and perfectly elastic spherical particles or atoms, which move in all directions, and are animated with different degrees of velocity in different gases. Confined in a vessel, the moving particles are constantly impinging against its sides and occasionally against each other, and such collisions take place without any loss of motion, owing to the perfect elasticity of the particles. Now if the containing vessel be porous, like a diffusiometer, then gas is projected through the open channels, by the atomic motion described, and escapes. Simultaneously the external air or gas, whatever it may be, is carried inwards in the same manner, and takes the place of the gas which leaves the vessel. To the same atomic or molecular motion is due the elastic force, with the power to resist compression, possessed by gases. The molecular movement is accelerated by heat and retarded by cold, the tension of the gas being increased in the first instance and diminished in the second. Even when the gas is present both within and without the vessel, and is therefore in contact with both sides of the porous plate, the movement is sustained without abatement—molecules continuing to enter and leave in equal number, although nothing of the kind is indicated by change of volume or otherwise. If the gases in communication be different but possess sensibly the same specific gravity and molecular velocity, as nitrogen and carbonic oxide do, an interchange of molecules also takes place without any change in volume. With gases opposed of unequal density and molecular velocity, the amount of penetration ceases of course to be equal in both directions.

These observations are preliminary to the consideration of the passage through a graphite plate, in one direction only, of gas under pressure, or under the influence of its own elastic force. It is to be supposed that a vacuum is maintained on one side of the porous septum, and that air or some other gas, under a constant pressure, is in contact with the other side. Now a gas may pass into a vacuum in three different modes, or in two modes besides that immediately before us.

1. The gas may enter the vacuum by passing through a minute aperture in a thin plate, such as a puncture in platinum foil made by a fine steel point. The rate of passage of different gases is then regulated by their specific gravities, according to a pneumatic law which was deduced by Professor John Robison, from Torricelli's well-known theorem of the velocity of efflux of fluids. A gas rushes into a vacuum with the velocity which a heavy body would acquire by falling from the height of an atmosphere composed of the gas in question, and supposed to be of uniform density throughout. The height of the uniform atmosphere will be inversely as the specific gravity of the gas, the atmosphere of hydrogen, for instance, sixteen times higher than that of oxygen. But as the velocity acquired by a heavy body in falling is not directly as the height, but as the square root of the height, the rate of flow of different gases into a vacuum will be inversely as the square root of their respective densities. The velocity of oxygen being 1, that of hydrogen will be 4, the square root of 16. This law has been experimentally verified*. The times of the effusion of gases, as I have spoken of it, are similar to those of the law of molecular diffusion; but it is important to observe that the phenomena of effusion and diffusion are distinct and essentially different in their nature. The effusion movement affects masses of gas, the diffusion movement affects molecules; and a gas is usually carried by the former kind of impulse with a velocity many thousand times greater than by the latter. The effusion velocity of air is the same as the velocity of sound.

2. If the aperture of efflux be in a plate of increased thickness, and so becomes a tube, the effusion-rates of gases are disturbed. The rates of flow of different gases, however, assume again a constant ratio to each other when the capillary tube is considerably elongated, when the length exceeds the diameter at least 4000 times. These new proportions of efflux are the rates of the "Capillary Transpiration of Gases."† The rates were found to be the same in a capillary tube composed of copper as they are in a tube of glass, and appear to be independent of the material of the capillary. A film of gas no doubt adheres to the inner surface of the tube, and the friction is really that of gas upon gas, and is consequently unaffected by the nature of tube-substance. The rates of transpiration are not governed by specific gravity, and are indeed singularly unlike the rates of effusion.

The transpiration-velocity of oxygen being 1, that of chlorine is 1·5, that of hydrogen 2·26, of ether vapour at low temperatures the same or nearly the same number as hydrogen, of nitrogen and carbonic oxide half the velocity of hydrogen, of olefiant gas, ammonia, and cyanogen 2 (double or nearly double that of oxygen), of carbonic acid 1·376, and of the gas of marshes 1·815. In the same gas the transpirability of equal volumes increases with density, whether occasioned by cold or pressure. The transpiration-ratios of gases appear to be in constant relation with no other known property of the same gases, and they form a class of phenomena remarkably isolated from all else at present known of gases.

There is one property of transpiration immediately bearing upon the penetration of the graphite plate by gases. The capillary offers to the passage of gas a resistance analogous to that of friction, proportional to the surface, and consequently increasing as the tube or tubes are multiplied in number and diminished in diameter, with the area of discharge preserved constant. The resistance to the passage of a liquid through a capillary was observed by Poiseuille to be nearly as the fourth power of the diameter of the tube. In gases the resistance also rapidly increases; but in what ratio, has not been observed. The consequence, however, is certain, that as the diameter of the capillaries may be diminished beyond any assignable limit, so the flow may be retarded indefinitely, and caused at last to become too small to be sensible. We may therefore have a mass of capillaries of which the passages form a large aggregate, but which are individually too small to permit a sensible flow of gas under pressure. A porous solid mass may possess the same reduced penetrability as the congeries of capillary tubes. Indeed the state of porosity described appears to be more or less closely approached by all loosely aggregated mineral masses, such as lime plaster, stucco, chalk, baked clay, non-crystalline earthy powders like hydrate of lime or magnesia compacted by pressure, and in the highest degree perhaps by artificial graphite.

3. A plate of artificial graphite, although it appears to be practically impenetrable to gas by either of the two modes of passage previously described, is readily penetrated by the agency of the molecular or diffusive movement of gases. This appears on comparing the time required for the passage of equal volumes of different gases under a constant pressure. Of the following three gases, oxygen, hydrogen, and carbonic acid, the time required for the passage of an equal volume of each through a capillary glass tube, in similar circumstances as to pressure and temperature, was formerly observed to be as follows:—

	Time of capillary transpiration.
Oxygen	1
Carbonic acid	0·72
Hydrogen	0·44

Through a plate of graphite, of half a millimetre in thickness, the same gases were now observed to pass, under a constant pressure of a column of mercury of 100 millimetres in height, in times which are as follows:—

	Time of molecular passage.	Square root of density (oxygen 1).
Oxygen	1	1
Hydrogen	0·2172	0·2502
Carbonic acid	1·1886	1·1760

It appears then that the times of passage through the graphite plate have no relation to the capillary transpiration-times of the same gases first quoted. The new times in question, however, show a close relation to the square roots of the densities of the respective gases, as is seen in the last table; and so far they agree with theoretical times of diffusion usually ascribed to the same gases.

The experiments were varied by causing the gases to pass into a Torricellian vacuum, and consequently under the full pressure of the atmosphere. The times of penetration of equal volume of gases were now—

	Times.	$\sqrt{\text{Density.}}$
Oxygen	1	1
Air	0·9501	0·9507
Carbonic acid	1·1860	1·1760
Hydrogen	0·2505	0·2502

* "On the Law of the Diffusion of Gases," *Transactions of the Royal Society of Edinburgh*, vol. xii., p. 222; or *Philosophical Magazine*, 1834, vol. ii., pp. 175, 269, 351.

† D. Bernoulli, J. Herepath, Joule, Krönig, Clausius, Clerk, Maxwell, and Cazin. The merit of reviving this hypothesis and first applying it to the facts of gaseous diffusion, is fairly due to Mr. Herapath. See *Mathematical Physics*, in two volumes, by John Herapath, Esq. (1847).

* *On the Motion of Gases*, Phil. Trans. 1846, p. 573.

† Phil. Trans. 1846, p. 591, and 1849, p. 349.

This penetration of the graphite plate by gases appears to be entirely due to their own proper molecular motion, quite unaided by transpiration. It seems to offer the simplest possible exhibition of the molecular or diffusive movement. This pure result is to be ascribed to the wonderfully fine porosity of the graphite. The interstitial spaces, or channels, appear to be sufficiently small to extinguish transpiration, or the passage of masses, entirely. The graphite becomes a molecular sieve, allowing molecules only to pass through.

With a plate of stucco, the penetration of gases under pressure is very rapid, and the volumes of air and hydrogen passing in equal times are as 1 to 2·891, which is a number for hydrogen intermediate between its transpiration-volume 2·04 and diffusive-volume 3·8, showing that the passage through stucco is a mixed result.

With a plate of biscuit ware, 2·2 millimetres in thickness, the volume of hydrogen rose to 3·754 (air = 1), approaching closely to 3·8, the molecular ratio.

The rate of passage of a gas through graphite appeared also to be closely proportional to the pressure.

Further, hydrogen was found to penetrate through a graphite plate into a vacuum, with sensibly the same absolute velocity as it diffused into air, establishing the important fact that the impelling force is the same in both movements. The molecular mobility may therefore be spoken of as the diffusive movement of gases; the passage of gas through a porous plate into vacuum, as diffusion in one direction or single diffusion; and ordinary diffusion, or the passage of two gases in opposite directions, as double, compound, or reciprocal diffusion.

Atmolysis.—A partial separation of mixed gases and vapours of unequal diffusibility can be effected by allowing the mixture to permeate through a graphite plate into a vacuum, as was to be expected from the preceding views. As this method of analysis has a practical character and admits of wide application, it may be convenient to distinguish it by a peculiar name. The amount of the separation is in proportion to the pressure, and attains its maximum when the gases pass into a nearly perfect vacuum. A variety of experiments were made on this subject, of which perhaps the most interesting were those upon the concentration of the oxygen in atmospheric air. When a portion of air confined in a jar is allowed to penetrate into a vacuum through graphite or unglazed earthenware, the nitrogen should pass more rapidly than the oxygen in the proportion of 1·0668 to 1, and the proportion of oxygen be proportionally increased in the air left behind in the jar. The increase in the oxygen actually observed when the air in the jar was reduced from 1 volume

To 0·5	volume, was	0·48 per cent.
0·25	" "	0·98 "
0·125	" "	1·54 "
0·0625	" "	2·02 "

Or, the oxygen increased from 21 to 23·02 per cent. in the last sixteenth part of air left behind in the jar.

The most remarkable effects of separation are produced by means of the *tube atmolyser.* This is simply a narrow tube of unglazed earthenware, such as a tobacco-pipe stem two feet in length, which is placed within a shorter tube of glass and secured in its position by corks, so as to appear like a Liebig's condenser. The glass tube is placed in communication with an air-pump, and the annular space between the two tubes is maintained as nearly vacuous as possible. Air or any other mixed gas is then allowed to flow in a stream along the clay tube, and collected as it issues. The gas so atmolysed is of course reduced in volume, much gas penetrating through the pores of the clay tube into the air-pump vacuum; and the slower the gas is collected the greater the proportional loss. In the gas collected, the denser constituent of the mixture is thus concentrated in an arithmetical ratio, while the volume ot the gas is reduced in a geometrical ratio. In one experiment the proportion of oxygen in the air after traversing the atmolyser was increased to 24·5 per cent., or 16·7 upon 103 oxygen originally present in the air. With gases differing so much in density and diffusibility as oxygen and hydrogen, the separation is of course much more considerable. The explosive mixture of two volumes of hydrogen and one volume of oxygen, gave oxygen containing only 9·3 per cent. of hydrogen, in which a taper burned without explosion; and with equal volumes of oxygen and hydrogen, the proportion of the latter was easily reduced from 50 to 5 per cent.

Interdiffusion of Gases—Double Diffusion.—The diffusiometer was much improved in construction by Prof. Bunsen, from the application of a lever arrangement to raise and depress the tube in the mercurial trough. But the mass of stucco forming the porous plate in his instrument was too voluminous, in my opinion, and, from being dried by heat, had probably detached itself from the walls of the glass tube. The result obtained of 3·4 for hydrogen, air being 1, is, I understand, no longer insisted upon by that illustrious physicist. It is indeed curious that my old experiments generally rather exceeded than fell short of the theoretical number for hydrogen:—

$$\sqrt{\frac{1}{0\cdot06926}} = 3\cdot7997.$$

With stucco as the material, the cavities in the porous plate plate form about one-fourth of its bulk, and affect sensibly the ratio in question, according as they are or are not included in the capacity of the instrument. Beginning the diffusion always with these cavities filled with hydrogen, the numbers now obtained with a stucco plate of 12 millimetres in thickness, dried without heat, were 3·783, 3·8, and 3·739 when the volume of the cavities of stucco is added to the air and hydrogen, and 3·931, 3·949, and 3·883 when such addition is not made to these volumes. The graphite plate, on the other hand, being thin, and the volume of its pores too minute to require to be taken into account, its action is not attended with the same uncertainty. With a graphite plate of 2 millimetres in thickness, the number for hydrogen into air was 3·876, and of hydrogen into oxygen 4·124, instead of 4. With a graphite of 1 millimetre in thickness, hydrogen gave 3·993 to air 1. With a graphite plate of 0·5 millimetre in thickness, the proportional number for hydrogen to air rose to 3·984, 4·068, and 4·067. A similar departure from the theoretical number was observed when hydrogen was diffused into oxygen or carbonic acid, instead of air. All these experiments were made over mercury and with dried gases. It appears that the numbers are most in accordance with theory when the graphite plate is thick, and the diffusion slow in consequence. If the diffusion be very rapid, as it is with the plates, something like a current is possibly formed in the channels of the graphite, taking the direction of the hydrogen and carrying back in mass a little air, or the slower gas, whatever it may be. I cannot account otherwise for the slight predominance which the lighter and faster gas appears always to acquire in diffusing through the porous septum.

Speculative Ideas respecting the Constitution of Matter.—It is conceivable that the various kinds of matter, now recognised as different elementary substances, may possess one and the same ultimate or atomic molecule existing in different conditions of movement. The essential unity of matter is an hypothesis in harmony with the equal action of gravity upon all bodies. We know the anxiety with which this point was investigated by Newton, and the care he took to ascertain that every kind of substance, "metals, stones, woods, grain, salts, animal substances," &c., are similarly accelerated in falling, and are therefore equally heavy.

In the condition of gas, matter is deprived of numerous and varying properties with which it appears invested when in the form of a liquid or solid. The gas exhibits only a few grand and simple features. These again may all be dependent upon atomic and molecular mobility. Let us imagine one kind of substance only to exist, ponderable matter; and further, that matter is divisible into ultimate atoms, uniform in size and weight. We shall have one substance and a common atom. With the atom at rest the uniformity of matter would be perfect. But the atom possesses always more or less motion, due, it must be assumed, to a primordial impulse. This motion gives rise to volume. The more rapid the movement the greater the space occupied by the atom, somewhat as the orbit of a planet widens with the degree of projectile velocity. Matter is thus made to differ only in being lighter or denser matter. The specific motion of an atom being inalienable, light matter is no longer convertible into heavy matter. In short, matter of different density forms different substances—different inconvertible elements as they have been considered.

What has already been said is not meant to apply to the gaseous volumes which we have occasion to measure and practically deal with, but to a lower order of molecules or atoms. The combining atoms hitherto spoken of are therefore not the molecules of which the movement is sensibly affected by heat, with gaseous expansion as the result. The gaseous molecule must itself be viewed as composed of a group or system of the preceding inferior atoms, following, as a unit, laws similar to those which regulate its constituent atoms. We have indeed carried one step backward and applied to the lower order of atoms ideas suggested by the gaseous molecule, as views derived from the solar system are extended to the subordinate system of a planet and its satellites. The advance of science may further require an indefinite repetition of such steps of molecular division. The gaseous molecule is then a reproduction of the inferior atom on a higher scale. The molecule or system is reached which is affected by heat, the diffusive molecule, of which the movement is the subject of observation and measurement. The diffusive molecules are also to be supposed uniform in weight, but to vary in velocity of movement, in correspondence with their constituent atoms. Accordingly the molecular volumes of different elementary substances have the same relation to each other as the subordinate atomic volumes of the same substances.

But further, these more and less mobile or light and heavy forms of matter have a singular relation connected with equality of volume. Equal volumes of two of them can coalesce together, unite their movement, and form a new atomic group, retaining the whole, the half, or some simple proportion of the original movement and consequent volume. This is chemical combination. It is directly an affair of volume, and only indirectly connected with weight. Combining weights are different, because the densities, atomic and molecular, are different. The volume of combination is uniform, but the fluids measured vary in density. This fixed combining measure—the *metron* of simple substances—weighs 1 for hydrogen, 16 for oxygen, and so on with the other "elements."

To the preceding statements respecting atomic and molecular mobility, it remains to be added that the hypothesis admits of another expression. As in the theory of light we have the alternative hypotheses of emission and undulation, so in molecular mobility the motion may be assumed to reside either in separate atoms and molecules, or in a fluid medium caused to undulate. A special rate of vibration or pulsation originally imparted to a portion of the fluid medium enlivens that portion of matter with an individual existence, and constitutes it a distinct substance or element.

With respect to the different states of gas, liquid, and solid, it may be observed that there is no real incompatibility with each other in these physical conditions. They are often found together in the same substance. The liquid and the solid conditions supervene upon the gaseous condition rather than supersede it. Gay-Lussac made the remarkable observation that the vapours emitted by ice and water, both at 0° C., are of exactly equal tension. The passage from the liquid to the solid state is not made apparent in the volatility of water. The liquid and solid conditions do not appear as the extinction or suppression of the gaseous condition, but someting superadded to that condition. The three conditions (or constitutions) probably always co-exist in every liquid or solid substance, but one predominates over the others. In the general properties of matter we have, indeed, to include still further (1) the remarkable loss of elasticity in vapours under great pressure, which is distinguished by Mr. Faraday as the Caignard-Latour state, after the name of its discoverer, and is now undergoing an investigation by Dr. Andrews, which may be expected to throw much light upon its nature; (2) the colloidal condition or constitution, which intervenes between the liquid and crystalline states, extending into both and affecting probably all kinds of solid and liquid matter in a greater or less degree. The predominance of a certain physical state in a substance appears to be a distinction of a kind with

those distinctions recognised in natural history as being produced in unequal development. Liquefaction or solidification may therefore not involve the suppression of either the atomic or the molecular movement, but only the restriction of its range. The hypothesis of atomic movement has been elsewhere assumed, irrespective of the gaseous condition, and is applied by Dr. Williamson to the elucidation of a remarkable class of chemical reactions which have their seat in a mixed liquid.

Lastly, molecular or diffusive mobility has an obvious bearing upon the communication of heat to gases by contact with liquid or solid surfaces. The impact of the gaseous molecule, upon a surface possessing a different temperature, appears to be the condition for the transference of heat, or the heat movement, from one to the other. The more rapid the molecular movent of the gas the more frequent the contact, with consequent communication of heat. Hence, probably, the great cooling power of hydrogen gas as compared with air or oxygen. The gases named have the same specific heat for equal volumes; but a hot object placed in hydrogen is really *touched* 3·8 times more frequently than it would be if placed in air, and four times more frequently than it would be if placed in an atmosphere of oxygen gas. Dalton had already ascribed this peculiarity of hydrogen to the high "mobility" of that gas. The same molecular property of hydrogen recommends the application of that gas in the air-engine, where the object is to alternately heat and cool a confined volume of gas with rapidity.

RESULTS OF THE MAGNETIC OBSERVATIONS AT THE KEW OBSERVATORY, FROM 1858 TO 1862, INCLUSIVE.

By Major-General Edward Sabine, F.R.S.

The first three sections of this paper are occupied by a discussion of the Laws of the Disturbances of the Magnetic Declination at Kew, derived from the photographic records of the Kew Observaiory between January 1, 1858, and December 31, 1862. In the first section a synoptical table is given, showing the direction and amount of the easterly and of the westerly deflections of the declination magnet at 24 equidistant epochs on each of 95 days of principal disturbance occurring in the years 1858 to 1862 inclusive. The deflections are measured from the normals of the same month and hour, computed from the undisturbed positions at the same epochs on the 1825 days comprised in the five years since the commencement of the photographic records. The phenomenal laws of the disturbances on the 95 days are then investigated, and are compared with the corresponding laws derived from a far larger number of observations in the same years, taken out by the well-known process employed by the author in the reduction of the observations of the colonial magnetic observatories. The result is shown to be that, so far as the laws of disturbances are concerned, the two processes furnish mutual confirmation—the laws being approximately the same whether they are derived from the whole body of the hourly positions, or from that portion only which includes 95 days (or on an average 19 days in each year) which were specially affected by disturbance,—but that, for the purpose of eliminating the effects of the disturbances in the subsequent investigation of the secular, periodical, and other minor magnetic variations, the process of elimination introduced by the author and employed by him for several years past in the reduction of the colonial observations has the advantage of separating from the whole body of the observations a far greater portion of the disturbing influence than would be gained by the simple omission of the observations on the 95 days. The laws of the *disturbance-diurnal* variation, thus found to be approximately the same whether obtained from the narrower or from the wider basis of investigation, are then stated, and are compared with the results of similar investigations recorded in the author's previous publications—the points of accordance or of difference being severally discussed in the third section.

The fourth section contains Tables of the "Diurnal Inequality," and of the "Solar-diurnal Variation" at Kew, showing the mean values at each hour and in each month. The "Diurnal Inequality" is explained as consisting of two principal constituents, viz. the "Disturbance-diurnal Variation," and the "Solar-diurnal Variation." It is obtained for each month by taking the differences between the mean positions of the magnet at each of the 24 hours, in the month, and the mean position in the month itself (viz. the mean of all the days and all the hours)—no omission whatsoever being made of disturbed observations.

The "Solar-diurnal Variation" is obtained by a similar process, after the separation and omission of all the observations which differed by a certain small and constant value from the normals of the same month and hour. By this process the effects of the "Casual and Transitory changes" are in a very great degree eliminated, and a very close approximation is obtained to the systematic diurnal action of the sun upon the direction of the horizontal magnet, apart from the effects of disturbances. The solar-diurnal variation thus obtained at Kew is compared with results similarly obtained at six other stations, viz. three stations in the interior of the two great northern continents, one equatorial station, and two stations in the middle latitudes of the southern hemisphere—thus generalizing upon a very extensive scale the action of the sun in producing the phenomena under notice.

The fifth section is occupied by a similar generalization of the facts which placed in evidence the existence of a semi-annual inequality in the solar-diurnal variation, having its epochs coincident, or very nearly so, with the sun's passage of the equator, and dependent consequently on the earth's position in its orbit. The sun's action in producing this semi-annual inequality is shown to be characteristically different from that which is manifested in the solar-diurnal variation itself, pointing apparently to a difference in the mode of the sun's action in the two cases.

The sixth section contains a tabular view of the "Lunar-diurnal Variation" at Kew, in each of the five years during which the photographic record has been maintained there; this is followed by a comparison with similar results at other stations on the globe, and a statement of the principal points of agreement or of difference which are shown thereby.

This paper is a continuation of the preceeding one. It consists two of sections, the seventh and eighth. In the seventh section the author discusses the secular change and annual variation of the declination; and in the eighth section, the annual variation or semi-annual inequality of the inclination and of the horizontal and total magnetic force.

Seventh Section.—The position of the horizontal magnet at 24 equidistant epochs in the day, tabulated from the photograms of the Kew declinometer, with the omission of the disturbed observations, as described in the former paper, are grouped in weekly means, forming 52 mean values, corresponding to the number of weeks in the year. A table is given of these weekly values, comprehending, in five colums, the five years from January 1858 to December 1862, inclusive, and from these a sixth column is formed, representing the mean declination in each of the 52 weeks of a mean or typical year, corresponding in this instance to the year 1860. The mean declination obtained from all the weekly results in the five years, and corresponding to its middle epoch July 1, 1860, is 21° 39′ 18·1″; and from a comparison of the mean declinations corresponding to July 1 in the columns which severally present the weekly values in the years from 1858 to 1862 inclusive, the mean value of the secular change corresponding to the period comprised in the table is deduced. A proportional part of the secular change is then applied with its appropriate sign to each of the weekly values in the mean or typical year. These should all correspond with the mean declination of the whole Table (viz. 21° 39′ 18·1″), or should exhibit only such small and unsystematic differences as might reasonably be ascribed to casual errors. The final column of the Table contains these differences, in which it is at once seen that they divide themselves into two distinct categories, distinguished by the minus sign in the semi-annual period from March 21 to September 21, and by the + sign from Sept. 21 to March 21. Hence the author infers the existence of a variation in the declination at Kew having an annual period, and consisting of a semiannual inequality with epochs coincident, or nearly so, with the sun's passage of the equator—the magnet being deflected towards the east when the sun is north, and towards the west when he is south of the equator. The amount of the semiannual inequality, as shown by the table, averages − 28·95″ in the weeks from March 21 to September 21, and + 29·9″ in those from September to March. The whole amount of the variation at Kew is therefore 58″·85.

The result thus obtained from the observations at Kew is compared with the result of an investigation of the corresponding phenomena at Hobarton in the Southern hemisphere, obtained from hourly observations of the declination during five years, commencing in October 1843, and terminating in September 1848. The observations themselves are published in the 2nd and 3rd volumes of the Hobarton Observations, and are treated, for the purposes of this paper, precisely in the same way as those of the Kew Observatory, forming a table strictly analagous to the one, previously described, at Kew. The final column of the Hobarton Table exhibits the differences, in each of the 52 weeks of the typical year, from the mean declination derived from the whole of the observations in the five years. The + and − signs in this column attest in as striking a manner as do those at Kew, the existence at Hobarton of a semi-annual inequality of which the epochs coincide, or very nearly so, with the sun's passage of the equator: the direction of the deflection is the same as at Kew, viz., of the north end of the magnet towards the east when the sun is north of the equator, and to the west when he is south of the equator. The amount of the deflection in the first-named semiannual period is, on the average, 19·1″ in each week: and in the opposite semiannual period 18″; making together an annual variation of 38″·1.

The author then refers to the result of a similar investigation of the phenomena at St. Helena in the equatorial zone, the particulars of which have been already published in the 2nd volume of the St. Helena Observations. The result, derived from eight years of observation, of which five years were hourly, evidences at that station, also the existence of a semi-annual inequality with epochs coinciding, or nearly so, with the equinoxes—the deflections being also in the same directions as those at Kew and Hobarton, viz., to the east when the sun is north, and to the west when he is south, of the equator. The amount of the annual variation thus produced is less at St. Helena than at either Kew or Hobarton—the semiannual difference being about 7″, and the annual variation 14″.

The author remarks that the difference in the amount of deflection at the three stations may, in part at least, be occasioned by the difference in amount of the antagonistic force of the earth's magnetism, tending to retain the magnet in its mean position in opposition to all disturbing causes. The antagonistic force, viz. the horizontal component of the earth's magnetic force, is approximately 5·6 (in British units) at St. Helena, 4·5 at Hobarton, and 3·8 at Kew.

In a note appended subsequently to the delivery of this paper, viz. on June 19, 1863, the author refers to a similar investigation of the phenomena at the Cape of Good Hope, published in 1851, in the 1st volume of the magnetical observations at that station. The volume contains the fortnightly means of the declination from July 1842 to July 1846, corrected for secular change, and collected in Table III., page 5, of that volume. The differences of the declination in each fortnight, so corrected, for the mean declination of the whole period, are shown in its final column. The mean of the thirteen fortnights (in the four years) between March 26 and Sept. 23, is 0′·4 more *easterly*, and of the thirteen fortnights between Sept. 24 and March 25, 0′·4 more *westerly* than the mean value—showing an annual variation of 0′·8 (or 48″), or a semiannual inequality averaging 24″ to the east in the thirteen fortnights from March 26 to Sept. 23, and 24″ to the west in the thirteen fortnights from Sept. 24 to March 25. This is in accordance with the conclusions at all the other stations at which the phenomena have been subjected to a suitable investigation. The antagonistic horizontal component of the earth's magnetism is approximately 4·5.

Eighth Section.—In the eighth section the author examines the evidence which the monthly determinations of the dip and of the horizontal component of the magnetic force at Kew afford of the existence of a semi-annual inequality in the absolute values of the dip and of the total magnetic force. The results of the

monthly determinations from April 1857 to March 1863 are exhibited in two tables, one appropriated to the dip, and the other to the horizontal force. The whole series of the determinations of the horizontal force were made with the same unifilar magnetometer and the same collimator magnet throughout, and also by the same observer, Mr. Chambers, one of the assistants at the Kew Observatory. In the monthly determinations of the dip from April 1857 to September 1860, twelve different circles, and their twenty-four needles, were occasionally employed, the mean of all the observations in each month being taken as the mean result in that month. There were also several observers in this part of the series, chiefly four. In the months from October 1860 to March 1863, one circle with its two needles were the sole instruments, and Mr. Chambers the sole observer. The probable error of a single monthly determination of the dip in the first part of the series, when several instruments and several observers were employed, is stated to be $\pm$ 0′·69; and in the second part of the series, obtained by a single circle and the same observer throughout, the probable error is $\pm$ 0′·75; whence it is inferred that the greater number of partial results which contributed to produce the monthly mean in the earlier period more than counterbalanced the diversities which might have been occasioned by the peculiarities of the different observers and of the different instruments. The probable error of a single monthly determination of the dip, after the application of the corrections for secular change and annual variation, is stated to be $\pm$ 0′·71, and of a single monthly determination of the horizontal force derived from the 72 monthly determinations $\pm$ ·0024.

The results of the monthly determination at Kew, as bearing upon the question of annual variation, may be briefly stated as follows:—1st. The dip is subject to an annual variation, which, on the average of the six years, amounts to 1′·35; consisting of a semi-annual inequality with epochs coinciding, or very nearly so, with the equinoxes; the mean dip being on the average 0′·65 lower than its annual mean value in the six months from April to September, and 0′·7 higher than its annual mean value in the six months from October to March. 2nd. That the horizontal force is subject to a semi-annual inequality having the same epochs—being on the average ·0013 higher than its annual mean in each of the six months from April to September, and ·0013 lower than its annual mean in each of the months from October to March. 3rd. That, combining the results of the dip and horizontal force, the total terrestrial magnetic force is expressed in British units by 10·3002 as its mean value in the months from April to September, and by 10·30347 in the months from October to March,—there being thus a difference of ·00327, by which the intensity of the magnetic force of the earth is greater in the months when the sun is south of the equator than in the months when he is north of the equator.

This conclusion is compared with the results obtained in a corresponding manner from the published observations of the Hobarton Observatory, viz., with the monthly determinations of the horizontal force in the five years from January 1846 to December 1850 inclusive, and with those of the dip in the ten years from January 1841 to December 1850 inclusive. From these data the conclusions are drawn, 1st, that at Hobarton the dip is subject to an annual variation amounting to 1′·18, consisting of a semiannual inequality with epochs coinciding or nearly so with the equinoxes—the (south) dip being on the average 0′·59 less in the months from April to September, and 0′·59 greater in the months from October to March than the mean annual value; and 2nd, that the horizontal force is subject to a similar semi-annual inequality, being ·0007 less than its mean value in the months from April to September, and ·0005 greater in the months from October to March; and combining these two results, that the total force at Hobarton is expressed in British units by 13·56882 in the months from October to March, and by 13·55195 in the months from April to September; the difference, ·01687, expresses the measure of the greater intensity of the earth's magnetic force when the sun is south than when he is north of the equator.

The author concludes this section of his investigations by drawing the attention of the Royal Society to this concurrent evidence, from the observations of the three observatories situated in parts of the globe so distant from each other, of a semi-annual inequality having such strong features of resemblance in both hemispheres, and remarks that it seems difficult to assign such effects to any other than to a cosmical cause. The "inequalities" may in themselves seem to be small; but judged of *scientifically*, *i. e.*, in the proportion they bear to their respective probable errors, they are large.

EXPERIMENTS MADE AT WATFORD ON THE VIBRATIONS OCCASIONED BY RAILWAY TRAINS PASSING THROUGH A TUNNEL.

BY SIR JAMES SOUTH, LL.D., F.R.S., MEMBER OF THE BOARD OF VISITORS OF THE ROYAL OBSERVATORY, GREENWICH.

These experiments were made in consequence of an attempt in 1846 to run a line of railway through Greenwich Park, in what seemed to several competent judges a dangerous proximity to the Royal Observatory.

It was abandoned, but (as Sir James South was informed) only for a time; and he thought it right to make some examination of the probable effects of such a vicinity, especially as to the power of a tunnel in deadening the vibrations.

The Watford tunnel was chosen as the observing station, being, on the high authority of Mr. Warburton, in ground very analagous to that on which the Royal Observatory stands; and every facility for making observations was afforded by the late Earl of Essex, through whose park and preserves this tunnel passes.

As the chief inconvenience to be feared from the proposed railway was the disturbance of the observations by reflection in mercury, it seemed best to take a series of these under circumstances as nearly as possible resembling those which might be expected at Greenwich. An Observatory was therefore erected, in which a large and powerful transit-instrument was mounted, with all the attention to stability that could be given in a first-class Observatory; and it had sufficient azimutual motion to enable the observer to follow the Pole-star in its whole course; so that night or day (if clear), he could have the reflected image of the star in the mercurial vessel, ready to testify against the tremors caused by any train.

The distance of the vessel from the nearest part of the tunnel was 302 yards, that proposed for Greenwich being 286 yards. The length of the tunnel is 1812 yards; its southern or London end is 643 yards from where the mercury was placed, its northern or Tring end 1281 yards; and about 64 feet of chalk and gravel lie above the brickwork of its crown. The author's preparations were not complete till December 1846, and then a continuance of cloudy weather interfered with observation till January the 11th, 1847, when and on the following nights he obtained results so decisive that he felt it his duty to communicate them at once to the then first Lord of the Admiralty, the late Lord Auckland, who was so satisfied with them that in a letter to Sir James, dated "Admiralty, Jan. 26, 1847," he recorded the impression they had made on his mind in the following terms:—"*They would be quite conclusive if the question of carrying a tunnel through Greenwich Park were again to be agitated.*" Sir James, however, continued the work to the end of March.

With the ordinary disturbance to which an Observatory is liable (as wind, carriages, or persons moving near it) the reflected image of a star breaks up into a line of stars, perpendicular to the longest side of the mercury vessel. With increased agitation, another line of stars perpendicular to the first appears, making a cross. With still more the cross becomes a series of parallel lines of stars; still more makes the image oscillate; and at last all becomes a confused mass of nebulous light. The first of these (the line) is not injurious to one class of observations; but the others are, and therefore the second (the cross) was taken as a measure of the beginning and end of injurious disturbance. Signal shots were fired when a train passed the southern entrance of the tunnel, and a shaft 1162 yards from it. Hence the train's velocity was obtained, and thence its position at any given time.

Upwards of 230 observations are given in detail, and their most important results are shown in a table, which contains the date, the distances at which the cross of stars begins and ceases to be visible, those at which the series of parallel lines is seen, the velocity in miles per hour, the weight of each engine, and also the length and weight of each train (when it could be identified).

This table proves that *in all cases* but one (which in fact is scarcely an exception) there is sufficient vibration to excite the cross at 670 yards, and that in 24 per cent. of the number it is seen beyond 1000, its maximum being 1176. At the southern end such disturbances reach far beyond the tunnel, while at the north they fall within it. From comparing them in the two cases, the author infers that the train's agitation extends laterally as far when it is in the tunnel as when in the open cutting. The amount of disturbance does not depend solely on the velocity and weight of the train, but also on other circumstances, of which prolonged action and length of train are the chief. In one instance, with only a velocity of 11·4 miles, the cross was seen at 1110 yards—a proof that no regulation of the speed in passing an Observatory at a distance of 300 or 400 yards would be of any avail.

The system of parallel lines is only seen between lines making angles of 45° with the perpendicular to the rails, that is, at distances under 427 yards; it scarcely ever is produced unless the cross be visible beyond 1000 yards.

These forms are also produced by the reports of cannon of twelve ounces calibre, at distances from 300 to 3000 yards; in the last case there is but a faint trace of the cross. In all, the appearance is momentary, not lasting in any case more than a second and a half. They are not produced by the roar of a two-pound rocket fired 82 feet from the mercury, though very loud. When the cannon were fired *in the tunnel*, where the perpendicular meets it, *two* sets of tremors were seen—one, he believes, propagated through the ground, the other through the air about a second later, the sound escaping probably through the shafts. Attempts were made to substantiate or refute this hypothesis; but the difficulties of *rapidly* shifting and unshifting the coverings prepared for the purpose were such as to compel him to relinquish them.

These observations were reduced in 1847; but conceiving all danger to the Royal Observatory was past, the author did not think it necessary then to proceed with them. As, however, no Observatory can now be considered secure from railway injury, he wishes to make them public, in hopes that they may be useful, not only to practical astronomy, but to some other departments of science.

INSTITUTION OF CIVIL ENGINEERS.

The Council of the Institution of Civil Engineers have awarded the following premiums for the session 1862-63:—

1. A Telford Medal, and a Telford Premium, in books, to John Brunton, M. Inst. C.E, for his "Description of the Line of Works of the Scinde Railway."
2. A Telford Medal, and a Telford Premium, in books, to James Robert Mosse, M. Inst. C.E., for his paper on "American Timber Bridges."
3. A Telford Medal, and a Telford Premium, in books, to Zerah Colburn, for his paper on "American Iron Bridges."
4. A Telford Medal, and a Telford Premium, in books, to Harrison Hayter, M. Inst. C.E., for his paper on "The Charing Cross Bridge."
5. A Telford Premium, in books, to William Michael Peniston, M. Inst. C.E., for his paper on "Public Works in Pernambuco, in the Empire of Brazil."
6. A Telford Premium, in books, to William Henry Preece, Assoc. Inst. C.E., for his paper "On Railway Telegraphs, and the Application of Electricity to the Signalling and Working of Trains."

7. A Telford Premium, in books, to Alexander Woodlands Makinson, M. Inst. C.E., for his paper "On some of the Internal Disturbing Forces of Locomotive Engines."

8. A Telford Premium, in books, to Daniel Miller, for his paper on "Structures in the Sea, without Cofferdams,—with a Description of the Works of the New Albert Harbour at Greenock."

9. A Telford Premium, in books, to Robert Crawford, Assoc. Inst. C.E., for his paper on "The Railway System of Germany."

10. A Telford Premium, in books, to William Cudworth, M. Inst. C.E., for his paper on "The Hownes Gill Viaduct, on the Stockton and Darlington Railway."

11. A Telford Premium, in books, to James Grant Fraser, M. Inst. C.E., for his paper "Description of the Lydgate and of the Buckhorn Weston Railway Tunnels."

12. A Watt Medal, and the Manby Premium, in books, to John Fernie, Assoc. Inst. C.E., for his paper "On the Manufacture of Duplicate Machines and Engines."

The following are the subjects for premiums for the session 1863-64:—

1. On the Decay of Materials in Tropical Climates, and the methods employed for arresting and preventing it.

2. On the Theory of Metal and Timber Arches.

3. On the Theory and Details of Construction of Wrought Iron Girder Bridges.

4. On Land-slips, with the best means of preventing or arresting them, with examples.

5. On the Pressure of Earth on Tunnels, and the conditions which limit its amount.

6. On the Theory and Practice of Artesian Well-boring, and of sinking large shafts, as now practised on the Continent.

7. On the result of contrivances for facilitating the Driving of Tunnels, or Drifts in Rock.

8. On the Principles to be observed in Laying-out lines of Railway through mountainous countries, with examples of their application in the Alps, the Pyrenees, the Indian Ghauts, the Rocky Mountains of America, and similar cases.

9. On the best means of preserving Railways in Alpine countries from interruptions from snow.

10. On the result of recent experience in Iron Permanent Way.

11. On the Principles to be observed in the designing and arrangement of Terminal and other Railway Stations, Repairing Shops, Engine Sheds, &c., with reference to the traffic and the rolling stock.

12. On Railway Ferries, or the Transmission of Railway Trains entire across Rivers, Estuaries, &c.

13. On Locomotive Engines for ascending Steep Inclines, specially when in combination with sharp curves, on Railways.

14. On the Working of Locomotive Engines in Long Tunnels, with frequent Stations.

15. On the Results of the Application of Giffard's Injector to the Boilers of Locomotive and other Engines.

16. On the Working Expenses of Railways, and the influence on these of the original design and construction.

17. On the Results of a series of observations on the Flow of Water from the Ground, in any large district; with accurately recorded Rain-Gauge Registries, in the same locality for a period of not less than twelve months.

18. On the Construction of Catch-water Reservoirs in Mountain Districts, for the supply of Towns, or for Manufacturing purposes.

19. Accounts of existing Water-works; including the source of supply, a description of the different modes of collecting and filtering, the distribution throughout the streets of Towns, and the general practical results.

20. On the Best Means of Improving the Water Supply of the Metropolis.

21. On the Structural Details, and the Results in Use, of Apparatus for the Filtration of large volumes of Water.

22. On the Drainage and Sewerage of large Towns; exemplified by accounts of the systems at present pursued, with regard to the level and position of the outfall, the form, dimensions, and materials of the sewers, the prevention of emanations from them, the arrangements for connecting the house drains with the public sewers, the best means of limiting the contamination of river from the sewage discharged into them, and the disposal of the sewage, whether in a liquid form, as irrigation, or in a fluid form, as deodorisation.

23. On the Results of the Employment of Steam Power on Canals, and of other measures for the Improvement of Canals as a means of conveyance for heavy traffic.

24. On Iron Paving, and a comparison of the Results attained by it, and by stone block paving, &c.

25. A History of any Fresh Water Channel, Tidal River, or Estuary,—accompanied by plans and longitudinal and cross sections,—including notices of any works which may have been executed upon it, and of the effects of the works; particularly of the relative value of Tidal and Fresh Water, and of the effect of Enclosures from the Tidal Area upon the general regime, of Sluicing where applied to the improvement of the entance or the removal of a Bar, and of Groynes, or Parallel Training Walls. Also of Dredging, with a description of the Machinery employed, and the cost of raising and depositing the material.

26. On the Results of a Series of Observations, illustrative of the modifications which the tidal wave undergoes in its passage up and down a river, or estuary.

27. On the Construction of Tidal, or other Dams, in a constant, or variable depth of water; and on the use of wrought iron in their construction.

29. On Graving Docks and mechanical arrangements having similar objects, with the conditions determining their relative applicability in particular cases, as dependent on the rise of tide, the depth of water, and other circumstances.

30. On the Arrangement and Construction of Floating Landing Stages, for passenger and other traffic, with existing examples.

31. On the different systems of Swing, Lifting, and other opening Bridges, with existing examples.

32. On the Construction of Lighthouses, their Machinery, and Lighting Apparatus; with notices of methods in use for distinguishing the different Lights.

33. On the Measure of Resistance to Steam Vessels at high Velocities.

34. On the results of the use of Tubular Boilers, and of Steam at an increased pressure, with or without superheating, for Marine Engines, noticing particularly the difference in weight and in speed, in proportion to the Horse-power and the Tonnage.

35. On the relative advantages of the Principle of Expansion, as applied in the Single long-stroke Cylinder Engine, in the Double Cylinder Engine, and in the three Cylinder Engine; and on the adaptation of the two latter to marine purposes.

36. On the Principles and Varieties of Construction of Blast Engines, with British and Foreign examples.

37. On the best description of Steam Fire Engines, and their power and efficiency, as compared with ordinary hand Fire Engines.

38. On the construction of, and the comparative duty performed by, modern Pumping Engines for raising Water, for the supply of Towns, or for the Drainage of Mines; noticing, in the latter case, the depth and length of the underground workings, the height of the surface above the sea, the geological formation, the contiguity of streams, &c.

39. On Turbines and other Water Motors of a similar character; and their construction and performance, in comparison with Water-wheels.

40. On the present systems of Smelting Iron Ores; and on the conversion of cast-iron into the malleable state, and of the manufacture of iron generally, comprising the distribution and management of Iron Works.

41. On the Manufacture of Iron for Rails and Wheel Tyres, having special reference to the increased capability of resisting lamination and abrasion; and accounts of the Machinery required for rolling heavy Rails, Shafts, and bars of Iron of large sectional area.

42. On the Manufacture of large Masses of Iron for the purpose of Warfare, as Armour Plates, etc.

43. On the construction of Rifled and Breech-loading Artillery; and on Initial Velocity, Range and Penetration of Rifled Projectiles, and the influence of Atmospheric Resistance.

44. On the use of Steel Bars and Plates in Engine-work, and Machinery for Boilers and for Shipbuilding, as well as for Bridges.

45. On the use of Steel in the Construction of Locomotive Engines, especially with reference to durability and the cost of repairs, in tyres and cranked axles, as compared with Iron of acknowledged good quality.

46. On the Bessemer, and other processes of Steel-making; on the present state of the Steel Manufacture on the Continent of Europe; and on the employment of castings in Steel for Railway Wheels and other objects.

47. On the safe working strength of Iron and Steel, including the results of experiments on the Elastic Limit of long bars of Iron, and on the rate of decay by rusting, &c., and under prolonged strains.

48. On the Transmission of Electrical Signals through Submarine Cables.

49. On the present relative position of English and Continental Engineering Manufactories, especially with reference to their comparative positions in respect of the cost, and the character of the work produced.

50. Memoirs and accounts of the Works and Inventions of any of the following Engineers:—Sir Hugh Middleton, Arthur Woolf, Jonathan Hornblower, Richard Trevithick, William Murdoch (of Soho), Alexander Nimmo, and John Rennie.

Original Papers, Reports, or designs, of these, or other eminent individuals, are particularly valuable for the Library of the Institution.

The competition for Premiums is not confined to Members, or Associates of the Institution, but is equally open to all persons, whether natives or foreigners.

The Council will not consider themselves bound to award any Premium, should the communication not be of adequate merit, but they will award more than one Premium, should there be several communications on the same subject deserving the mark of distinction.

The communications must be forwarded, on or before the 1st of January, 1864, to the house of the Institution, No. 25, Great George street, Westminster, S.W., where further information may be obtained.

THE CHEMICAL SOCIETY.

ON SOME EFFECTS OF HEAT ON FLUIDS.

By W. R. Grove, Esq., Q.C., F.R.S., Etc.

The paper of M. Donny (*Mémoires de l'Académie Royale de Bruxelles*, 1843) makes known the fact that in proportion as water is deprived of air, the character of its ebullition changes, becoming more and more abrupt, and boiling like sulphuric acid with *soubresauts*, and that between each burst of vapour the water reaches a temperature above its boiling point. To effect this, it is necessary that the water be boiled in a tube with a narrow orifice, through which the vapour issues; if it be boiled in an open vessel, it continually re-absorbs air and boils in the ordinary way.

In my experiments on the decomposition of water by heat, I found that with the oxy-hydrogen gas given off from ignited platinum plunged into water, there was always a greater or less quantity of nitrogen mixed; this I could never entirely get rid of, and I was thus led into a more careful examination of the phenomenon of boiling water, and set before myself this problem—what will be the effect of heat on water perfectly deprived of air or gas?

Two copper wires were placed parallel to each other through the neck of a Florence flask, so as nearly to touch the bottom; joining the lower ends of these was a fine platinum wire, about 1½in. long, and bent horizontally into a curve. Distilled water which had been well boiled, and cooled under the receiver of an air-pump, was poured into this flask so as to fill about one-fourth of its capacity It was then placed under the receiver of an air-pump, and one of the copper wires brought in contact with a metallic plate covering the receiver, the other bent backwards over the neck of the flask, and its end made to rest on the pump plate. By this means, when the terminal wires from a voltaic battery were made to touch, the one the upper and the other the lower plate, the platinum wire would be heated, and the boiling continued indefinitely in the vacuum of a very excellent air-pump. The effect was very curious; the water did not boil, but at intervals a burst of vapour took place, dashing the water against the sides of the flask, some escaping into the receiver. (There was a projection at the central orifice of the pump plate to prevent this overflow getting into the exhausting tube.)

After each sudden burst of vapour. the water became perfectly tranquil, without a symptom of ebullition until the next burst took place. These sudden bursts occurred at measured intervals, so nearly equal in time that, had it not been for the escape from the flask, at each burst, of a certain portion of water, the apparatus might have served as a timepiece.

I showed this experiment at one of my lectures at the time, as affording an illustration of the action of the geysers, of which it seemed to me to afford a rational explanation. Supposing a source of heat at a certain depth beneath the earth's surface, and subterranean wells whose only communication with the air was a narrow tube, probably formed by the issue of vapour, the air, if any, dissolved in the water of these wells would be expelled, and the boiling would take place at intervals and by sudden bursts instead of in the ordinary way.

This experiment, though instructive, did not definitely answer the question I had proposed, as I could not of course ascertain whether there was some minute residuum of gas which would form the nucleus for each ebullition, and I proceeded with others. A tube of glass, 5ft. long, and $\frac{1}{10}$ths inch internal diameter, was bent into a V shape; into one end a loop of platinum wire was hermetically sealed with great care, and the portion of it in the interior of the tube was platinised. When the tube had been well washed, distilled water, which had been purged of air as before, was poured into it to the depth of 8 inches, and the rest of the tube filled with olive oil; when the V was inverted, the open end of the tube was placed in a vessel of olive oil, so that there would be 8in. of water resting on the platinum wire, separated from the external air by a column of 4ft. 4in. of oil. The projecting exterminals of the platinum wire were now connected with the terminals of a voltaic battery and the water heated; some air was freed and ascended to the level of the tube—this was made to escape by carefully inverting the tube so as not to let the oil mix with the water, and the experiment continued. After a certain time the boiling assumed a uniform character, not by such sudden bursts as in the Florence flask experiment, but with larger and more distinct bursts of ebullition than in its first boiling.

The object of platinising the wire was to present more points for the ebullition, and to prevent *soubresauts* as much as possible.

The experiment was continued for many hours, and in some repetitions of it for days. After the boiling had assumed a uniform character, the progress of the vapour was carefully watched, and as each burst of vapour condensed in the oil, which was kept cool, it left a minute bead of gas, which ascended through the oil to the bend of the tube: a bubble was formed here which did not seem at all absorbed by the oil. This was analysed by a eudiometer, which I will presently describe, and proved to be nitrogen. The beads of gas, when viewed through a lens and micrometer scale at the same height in the tube, appeared as nearly as may be of the same size. No bubble of vapour was condensed completely, or without leaving this residual bubble. The experiment was frequently repeated, and continued until the water was so nearly boiled away, that the oil, when disturbed by the boiling, nearly touched the platinum wire; here it was necessarily stopped.

To avoid any question about the boiling being by electrical means, similar experiments were made with a tube, without a platinum wire, closed at its extremity, and the boiling was produced by a spirit lamp. The effects were the same, but the experiment was more difficult and imperfect, as the bursts of vapour were more sudden, and the duration of the intervals more irregular.

The beads of gas were extremely minute, just visible to the naked eye. I cannot find any record of their exact measure.

In these experiments there was no pure boiling of water, *i.e.*, no rupture of cohesion of the molecules of water itself, but the water was boiled, to use M. Donny's expression, by evaporation against a surface of gas.

It is hardly conceivable that air could penetrate through such a column of oil, the more so as the oil did not perceptibly absorb the nitrogen freed by the boiling water and resting in the bend of the tube; but, to meet this conjectural difficulty, the following experiment was made. A tube, 1ft. long and $\frac{2}{10}$ths inch internal diameter, bent into a slight angle, had a bulb of ¾in. diameter blown on it at the angle; this angle was about 3in. from one end and 9in. from the other; a loop of platinum wire was sealed into the shorter leg, and the whole tube and bulb filled with and immersed into mercury; water, distilled and purged of air as before, was allowed to fill the short leg, and by carefully adjusting the inclination, the water could be boiled so as to allow bubbles to ascend into the bulb and displace the mercury. The effect was the same as with the oil experiment, no ebullition without leaving a bead of gas; the gas collected in the bulb, and was cut off by what may be termed a valve of mercury, from the boiling water, then allowed to escape, and so on. The experiment was continued for many days, and the bubbles analysed from time to time; they proved, as before, to be nitrogen, and, as before, continued indefinitely.

A similar experiment was made without the platinum wire, and though, from the greater difficulties, the experiment was not so satisfactory, the result was the same.

As the mercury of the common barometer will keep air out of its vacuum for years, if not for centuries, there could be no absorption here from the external atmosphere, and I think I am fairly entitled to conclude from the above experiments,—which I believe went far beyond any that have been recorded,—that no one has yet seen the phenomenon of pure water boiling, *i.e.*, of the disruption of the liquid particles of the oxy-hydrogen compound so as to produce vapour which will, when condensed, become water, leaving no permanent gas. Possibly, in my experiment of the decomposition of water by ignited platinum, it may be that the sudden application of intense heat, and in some quantity, so forces asunder the molecules that, not having sufficient nitrogen dissolved to supply them with a nucleus for evaporation, the integral molecules are severed, and decomposition takes place. If this be so, and it seems to me by no means a far-fetched theory, there is probably no such thing as boiling, properly so called, and the effect of heat on liquids in which there is no dissolved gas may be to decompose them.

Considerations such as these led me to try the effect of boiling on an elementary liquid, and bromine occurred as the most promising one to work upon. As bromine could not be boiled in contact with water, oil, or mercury, the following plan was ultimately devised. A tube, 4ft. long and $\frac{1}{10}$ths inch diameter, had a platinum loop sealed into one closed extremity; bromine was poured into the tube to the height of 4in.; the open end of the tube was then drawn out to a fine point by the blow-pipe, leaving a small orifice; the bromine was then heated by a spirit lamp; and when all the air was expelled, and a jet of bromine vapour issued from the point of the tube, it was sealed by the blow-pipe. There was then, when the bromine vapour had condensed, a vacuum in the tube above the bromine. The platinum loop was now heated by a voltaic battery and the bromine boiled: this was continued for some time, care being taken that the boiling should not be too violent. At the end of a certain period—from half-an-hour to an hour—the platinum loop gave way, being corroded by the bromine: the quantity of this had slightly decreased. On breaking off, under water, the point of the tube, the water mounted and showed a notable quantity of permanent gas, which on analysis proved to be pure oxygen. As much as a quarter of a cubic inch was collected at one experiment. The platinum wire, which had severed at the middle, was covered with a slight black crust, which, suspecting to be carbon, I ignited by a voltaic spark in oxygen in a small tube over lime water; it seemed to give a slight opalescence to the liquid, but the quantity was so small that the experiment was not to be relied on. No definite change was perceptible in the bromine; it seemed to be a little darker in colour and had a few black specks floating in it, which I judged to be minute portions of the same crust which had formed on the platinum wire, and which had become detached.

The experiment was repeated with chloride of iodine, and with the same result, except that the quantity of oxygen was greater; I collected as much as half a cubic inch in some experiments, from an equal quantity of chloride of iodine, the platinum wire, however, was more quickly acted on than with the bromine, and the glass of the tube around it to some extent.

Melted phosphorus was exposed to the heat of the voltaic disruptive discharge by taking this between platinum points in a tube of phosphorus, similarly to an experiment of Davy's, but with better means of experimenting; a considerable quantity of phosphuretted hydrogen was given off, amounting in several experiments to more than a cubic inch.

A similar experiment was made with melted sulphur and sulphuretted hydrogen given off, but not in such quantities as the phosphuretted hydrogen. I tried in vain to carry on these experiments beyond a certain point; the substance became pasty, mixed with platinum from the arc, and from the difficulty of working with the same freedom as when they were fresh, the glass tubes were always broken after a certain time. Had I time for working on the subject now, I should use the discharge from the Rhumkorf coil, which had not been invented

at the period of these experiments. At a subsequent period, when this discharge was taken in the vacuous receiver of an air-pump from a metallic point to a metallic capsule containing phosphorus, a considerable yellow deposit lined the receiver, which, on testing, turned out to be allotropic phosphorus. No gas is, however, given off. I had an air-pump (described, *Phil. Trans.*, 1852, p. 101) which enabled me to detect very small quantities of gas, but I could get none. It was in making these experiments that I first detected the striæ in the electric discharge, which have since become a subject of such interesting observations, which are seen, perhaps, more beautifully in this phosphorus vapour than in any other medium, and which cease, or become very feeble, where the allotropic phosphorus is not produced.

I tried also phosphorus highly heated by a burning glass in an atmosphere of nitrogen, but could eliminate no perceptible quantity of gas, though the phosphorus was changed into the allotropic form.

It is not difficult to understand why gas is not perceptibly eliminated in the last two experiments; the effect is probably similar to that described in my paper on "The Decomposition of Water by Heat," where, when the arc or electric spark is taken in aqueous vapour, a minute bubble of oxyhydrogen gas is freed and disseminated through the vapour, recombination being probably prevented by this dilution; but, however long the experiment may be continued, no increased quantity of the gas is obtained, all beyond this minute quantity being recombined. If, however, the bubble of gas be collected, by allowing the vapour to cool, and then expelled, a fresh portion is decomposed, and so on.

So with the phosphorus in the experiments in the air-pump and with the burning glass, if any gas is liberated it is probably immediately recombined with the phosphorus; possibly a minute residuum might escape recombination, but the circumstances of the experiment did not admit of this being collected, as the gas was with the aqueous vapour.

When, on the other hand, the gas freed is immediately cut off from the source of heat, as when the spark is taken in liquids, an indefinite quantity can be obtained.

Decomposition and the elimination of gas may thus take place by the application of intense heat to a point in a liquid, or also in gas or vapours; but in the latter case it is more likely to be masked by the quantity of gas or vapour through which it is disseminated.

I believe there are very few gases in which some alteration does not take place by the application of the intense heat of the voltaic arc or electric spark. If the arc be taken between platinum points in dry oxygen gas over mercury, the gas diminishes indefinitely, until the mercury rises, and by reaching the point where the arc takes place, puts an end to the experiment. I have caused as much as a cubic inch of oxygen to disappear by this means. I at one time thought this was due to the oxidation of the platinum, but the high heat renders this improbable, and the deposit formed on the interior of the glass tube in which the experiment is made has all the properties of platinum-black; so if the spark from a Ruhmkorf coil be taken in the vapour of water for several days, a portion of gas is formed which is pure hydrogen, the oxygen freed being probably changed into ozone and combined with the mercury or dissolved by the water.

I have alluded to the eudiometer by which I analysed the gases obtained in these experiments; it was formed simply of a tube of glass frequently not above 2½ millemetres in diameter, with a loop of wire hermetically sealed into one end, the other having an open bell-mouth. By a platinum wire a small bubble of the gas to be examined could be got up through water or mercury into the closed end of the tube, and by the addition of a bubble of oxygen or hydrogen gas, a very accurate analysis of very minute quantities of gas could be made; I have analysed by this means quantities no larger than a partridge-shot.

I need hardly allude to results on the compound liquids such as oils and hydrocarbons, as the fact that permanent gas is given off in boiling such liquids would not be unexpected; but the above experiments seem to show that boiling is by no means necessarily the phenomenon that has generally been supposed, viz., a separation of cohesion in the molecules of a liquid from distension by heat. I believe, from the close investigation I made into the subject, that (except with the metals, on which there is no evidence) no one has seen the phenomenon of pure boiling without permanent gas being freed, and that what is ordinarily termed boiling arises from the extrication of a bubble of permanent gas either by chemical decomposition of the liquid, or by the separation of some gas associated in minute quantity with the liquid, and from which human means have hitherto failed to purge it. This bubble once extricated, the vapour of the liquid expands it, or, to use the appropriate phrase of M. Donny, the liquid evaporates against the surface of the gas.

My experiments are, in a certain sense, the complement of his. He showed that the temperature of the boiling point was raised in some proportion as water was deprived of air, and that under such circumstances the boiling took place by *soubresauts*. I have, I trust, shown that when the vapour liberated by boiling is allowed to condense, it does not altogether collapse into a liquid, but leaves a residual bubble of permanent gas, and that at a certain point this evolution becomes uniform.

Boiling, then, is not the result of merely raising a liquid to a given temperature; it is something much more complex.

One might suppose that with a compound liquid the initial bubble by which evaporation is enabled to take place might, if all foreign gas were or could be extracted, be formed by decomposition of the liquid, but this could not be the case with an elementary liquid; whence the oxygen from bromine or the hydrogen from phosphorus and sulphur? as with the nitrogen in water, it may be that a minute portion of oxygen, hydrogen, or of water is inseparable from these substances, and that if boiled away to absolute dryness, a minute portion of gas would be left for each ebullition.

With water there seems a point at which the temperature of ebullition and the quantity of nitrogen yielded become uniform, though the latter is excessively minute.

The circumstances of the experiments with bromine, phosphorus, and sulphur did not permit me to push the experiment so far as was done with water; but, as far as it went, the result was similar.

When an intense heat, such as that from the electric spark or voltaic arc, is applied to permanent gas, there are, in the greater number of cases, signs either of chemical decomposition or of molecular change; thus compound gases, such as hydrocarbons, ammonia, the oxides of nitrogen, and many others, are decomposed. Phosphorus is vapour is reduced to allotropic phosphorus, oxygen to ozone, which, according to present experience, may be viewed as allotropic oxygen. There may be many cases where, as with aqueous vapour, a small portion only is decomposed, and this may be so masked by the volume of undecomposed gas as to escape detection, if, for instance, the vapour of water were incondensable, the fact that a portion of it is decomposed by the electric spark or ignited platinum would not have been observed.

All these facts show that the effect of intense heat applied to liquids and gases is far more complex, and presents greater interest to the chemist than has generally been supposed. In far the greater number of cases, possibly in all, it is not mere expansion into vapour which is produced by intense heat, but there is a chemical or molecular change. Had circumstances permitted I should have carried these experiments further and endeavoured to find an *experimentum crucis* on the subject; there are difficulties with such substances as bromine, phosphorus, &c., arising from their action on the substances used to contain and heat them, which are not easy to vanquish, and those who may feel inclined to repeat these experiments will find these difficulties greater than they appear in narration: but I do not think they are insuperable, and hope that, in the hands of those who are fortunate enough to have time at their disposal, they may be overcome.

To completely isolate a substance from the surrounding air, and yet be able to experiment on it, is far more difficult than is generally supposed. The air-pump is but a rude mode for such experiments as are here detailed.

Caoutchouc joints are out of the question; even platinum wires carefully sealed into glass, though, as far as I have been able to observe, forming a joint which will not allow gas to pass, yet it is one through which liquids will effect a passage, at all events when the wires are repeatedly heated.

In some experiments with the ignited platinum wire hermetically sealed into a tube of glass, the end of the tube containing the platinum wire was placed in a larger tube of oil, to lessen the risk of cracking the glass. After some days experimenting, though the sealing remained perfect, a slight portion of carbon was found in the interior liquid. This does not affect the results of my experiments, as I repeated them with glass tubes closed at the end and without platinum wires, and also without the oil-bath; but it shows how difficult it is to exclude sources of error. When water has been deprived of air to the greatest practicable extent it becomes very avid for air. The following experiment is an instance of this: A single pair of the gas-battery, the liquid in which was cut off from the external air by a greased glass stopper, having one tube filled with water, the other with hydrogen, the platinised platinum plates in each of these tubes were connected with a galvanometer, and a deflection took place from the reaction of the hydrogen on the air dissolved in the water. After a time the deflection abated, and the needle returned to zero, all the oxygen of the air having become combined with the hydrogen. If now the stopper were taken out, a deflection of the galvanometric needle immediately took place, showing that the air rapidly enters the water as water would a sponge. Absolute chemical purity in the ingredients is a matter, for refined experiments, almost unattainable. The more delicate the test, the more some minute residual product is detected; it would seem (to put the proposition in a somewhat exaggerated form) that in nature everything is to be found in anything if we carefully look for it.

I have indicated the above sources of error to show the close pursuit that is necessary when looking for these minute residual phenomena. Enough has, I trust, been shown in the above experiments to lead to the conclusion that, hitherto, simple boiling, in the sense of a liquid being expanded by heat into its vapour without being decomposed or having permanent gas eliminated from it, is a thing unknown. Whether such boiling can take place may be regarded as an open question, though I incline to think it cannot; that if water, for instance, could be absolutely deprived of nitrogen, it would not boil until some portion of it was decomposed; that the physical severance of the molecules by heat is also a chemical severance. If there be anything in this theoretic view, there is great promise of important results on elementary liquids, if the difficulties to which I have alluded can be got over.

The constant appearance of nitrogen in water, when boiled off out of contact with the air almost to the last drop, is a matter well worthy of investigation. I will not speculate on what possible chemical connection there may be between air and water; the preponderance of these two substances on the surface of our planet, and the probability that nitrogen is not the inert diluent in respiration that is generally supposed, might give rise to not irrational conjectures on some unknown bond between air and water. But it would be rash to announce any theory on such a subject; better to test any guess one may make, by experiment, than to mislead by theory without sufficient data, or to lessen the value of facts by connecting them with erroneous hypotheses.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—We regret that, owing to the meetings of the Association commencing so late in the month, we have only been able to insert the President's Address,—to which very considerable interest is deservedly attached,—and two papers by Professor Rankine. We purpose, however, giving in our next issue a selection of the most important of the papers read at the meetings of the several sections.

SCOTTISH SHIPBUILDERS' ASSOCIATION.

ON INDIAN RIVER STEAMERS.

By Mr. Robert Leys.

In laying before you a few suggestions on Indian river navigation, I will confine my remarks to the river Indus and its tributaries. It is at certain seasons of the year shallow and tortuous, with a current of from 1½ to 3 knots per hour, according to the season—having, like the Nile, periodical inundations. At one place (Sukkur), where a rocky island divides the stream, the current at the high season is from 8 to 9 knots, but this pass is only about three-fourths of a mile in length. There is another peculiarity of the Indus: its shifting channels. It often happens that where there is 8 or 9 feet water one week, in the following week there will not be as many inches. The banks are also often swept away, taking with them whole native villages, so that any system of buoying off the channel is out of the question.

The navigation is guided by native pilots, who know by the surface of the water the channel to take; and they are often deceived, at times getting into a *cul de sac*, when they must about ship and seek another channel. As to the prospects of trade on the river I do not think there can be a doubt, as a glance at the map of India will show that it runs through a large tract of well-populated country. At about 500 miles from its mouth it is joined by the Chunab and Sutlej, the Chunab being again joined by the Jelum and Ravee, the Indus holding on its course north until it penetrates the Himalaya mountains and enters Tibet. However, it has not been navigated further north than Attock, and this may be said to be the utmost point navigable. The principal towns are Sukkur on the Indus, Moultan on the Chunab, Lahore on the Ravee, and Ferozpoor on the Sutlej, thus forming the Punjab, or country of the five rivers.

Before describing the kind of vessels I would suggest for its navigation, I will take a review of the vessels that have already been tried. Shortly after the conquest of Scinde by Sir Charles Napier, the East India Company, seeing the advantage of steam, had two small steamers built of light draught. They were 80ft. long and 18ft. beam; their load draught was 4ft., with engines of 50 nominal horse-power. This was a great step from the native boats; but owing to their small power and deep draught of water, they could only take Government stores and a few Government passengers; and, although the distance from Kurrachee to Moultan is only about 800 miles, they generally took five weeks to reach the latter place. The downward passage was accomplished in from seven to ten days. This will even look a long time; but it must be remembered that they can only steam in day-light, laying to at the bank at night, and taking their fuel (wood) for the following day.

They have gradually enlarged the size of the steamers as they built new ones, until the last built, just before India was united to the British Crown, were length 166ft., beam 28ft., depth of hold 8ft., nominal horse-power 120, their load draught 4ft. 6in. Now the great fault of these vessels was their draught of water and the length of time on the passage, twenty days being their average up passage; and at the high season of the river they could not go through Sukkur Pass, their cargo being unshipped below and transported in bullock carts to the upper side of the pass, and then put on board another steamer.

The next move for navigating the Indus was by a joint-stock company, with a patent for navigating shallow rivers. This was a steamer with an articulated train of barges, something like your mud barges on the Clyde, only the bow of each barge was fitted into the stern of the preceding one, which was part of a circle, and tied together with triangular draw-bars working on ball-and-socket joints. The steamer was 200ft. long, 20ft. beam, and 5ft. depth of hold. The first or joining barge was 40ft. long, 18ft. beam, and the same depth as the steamer. This barge was concave at both ends, so as to join the convex stern of the steamer and convex bow of the following barge. To complete the train, other four barges were joined in a similar manner, 100ft. long, 18ft. beam, and 5ft. depth of hold, the whole train being 640ft. long. The last barge was for passengers, having a deck house 60ft. by 16ft. Her stern was spoon shaped, with a rudder attached. The bow of the steamer was also of the spoon pattern. The displacement of the steamer with engines and boilers was 185 tons, and the mean draught was 2ft. 2½in. The joining barge displaced 18 tons, draught of water 10½in.; each of the 100ft. barges displaced 39 tons, draught 10in.; and the passenger barge displaced 63 tons, draught of water 1ft. 4in. This was their displacement without any cargo. The train was fitted with a great number of novelties, among which was a self-acting telegraph, to indicate to the steersmen of the other barges what direction the bow of the steamer was taking, the steamer, as it were, acting as a bow rudder to the rest of the train. On the steamer's bow was placed a frame with thirty lanterns, to throw a blaze of light ahead, to enable them to proceed in the darkest night. The paddle-wheels were 6in. below the keel, that they might be used as crawlers when the train had not water to float in, having supplementary engine, fitted with wheel gearing, to reduce the speed when crawling.

The last barge of the train was fitted with a drop pile. This was to pin the tail of the train if the bow should get aground when going with the stream, and prevent the doubling up of the train. None of these novelties were of much service. Once at Ghizree the steamer was crawled off with six inches less water than her draught, but the bottom was a stiff clay. At another time in Kurrachee harbour, where the bottom was sand, they just dug a hole in the sand without moving the vessel. The drop pile was once tried, but although it was an elm log 14in. square, it snapped across like a carrot.

A number of experimental trials were made at a measured distance of 3850 yards in Kurrachee harbour, the mean results of which were as follows:—With steamer alone, loaded to a mean draught of 3ft., the speed attained, with an indicated horse power of 273·58, was 9·374 English miles. Her immersed midship section was 58 square feet. This was a very poor result, but from her block stern and formation of the bow little else could be expected. The next trial was with the 40ft. and one of the 100ft. barges connected, loaded to 2ft. 10in. With this a speed of 7·19 English miles was attained, the indicated power being 302·79 horse-power, the immersed section of steamer being the same as on the former trial, the length of steamer and barges 340ft. Another 100ft. barge was connected, and the speed was reduced to 5·75 English miles, indicated power 332 horse power. Another 100ft. barge was connected, thus making the length of train 540ft. The speed was reduced to 4·33 English miles. The slip of the wheel on this trial was 51 per cent. I may mention that the engines were high pressure, and the steam carried on these trials was from 90 to 110 lbs.

After these trials, the train of steamer, 40ft. barge, and 100ft. barge, made an attempt to ascend the Indus, but although the patentee was on board, with a crew of thirty-two Europeans and forty-two natives, it was twenty-three days in making 420 miles. It was found quite unmanageable in the currents, oftener in a zig-zag than in a straight line, first on the one bank then on the opposite. A second attempt was made, which was equally unsuccessful.

After this failure, alterations were made in the steering gear, and a number of trials made in the harbour with no better result as to speed,—although the steering was rather improved. The train again started for the river, but before it was well out of the harbour one of the arms of the draw-bar broke, and the barges doubled round on the steamer, breaking in the stern and after compartment, when the steamer filled and sank in twenty-four feet water, the crew getting on to the barges. No lives were lost. Thus ended the train system, for a time at least, although a second train was ready for launching.

The steamer of this second train had now her block stern cut off, and lengthened 20ft., with a pretty fine after run: the barges got bows and sterns put to them to suit them for being lashed alongside the steamer, or towed astern, as might be wanted. This steamer started for Moultan with one barge 140 feet long, going through Sukkur Pass at the height of the inundations, and reached Moultan in twenty-five days. This was a poor result, but it was only making the best of a bad job. Since then she has taken two barges and made the passage pretty regularly.

The next move for navigating the Indus was with steamers and railway combined—the Scinde Railway and Indus Flotilla.

The Scinde railway starts from the Island of Keamaree, which forms the east side of the harbour of Kurrachee, and has its terminus at Kottree, on the banks of the Indus, about 130 miles from its mouth. This line is 110 miles long, and makes a very considerable saving in distance, but much more in time; the shortest water route to Kottree being 230 miles, but can only be used about seven months in the year, the N.W. monsoons causing a heavy surf all along that coast from April to September. The other water passage is by the creeks, which are very tortuous, and the distance to Kottree by them is computed at about 400 miles.

The Indus Flotilla Company had a steamer built on the Thames by a celebrated builder, and tried on that river. Her dimensions were, length 200ft., beam 38ft., and depth of hold 8ft. She was propelled by a condensing three-cylinder oscillating engine, two of the cylinders being below and the third above the deck. At her trial on the Thames she attained a speed of 13 miles per hour, with 688 indicated horse-power; her draught of water was 1ft. 11in., and her immersed midship section 70ft. This was no great result, but it exceeded anything she ever did in India. Whether that her boilers where not suited for wood fuel, or that the heavy teak decks and stringers fitted into her in India, was the cause of her falling off, I do not pretend to say: it might be both combined; but the fact was she did not make over 10 miles an hour in still water when tried in India. She was very unfortunate, breaking one of her piston-rods and smashing a cylinder. There were other six steamers built from this model one, and from the last accounts only one of them had been tried. The results were so unfavourable that not one of them was taken off the contractor's hands after being put up in Kurrachee, the company having purchased some of the boats belonging to the East India Company, and are carrying on their trade with them.

This is pretty nearly what has been done in navigating the Indus. To

know the rocks that others struck on was my reason for dwelling so long on what has been done already. It is a great part of the battle to know the dangers ahead.

I will now lay before you what sort of vessels I think would suit that or similar rivers. Light draught is of the utmost importance, combined with strength and moderate speed. To secure the first two qualities, steel or homogenous metal should be used in the plates, frames, decks, and beams, and from the late improvements in the manufacture of the latter metal, it would not be much more expense, taking into account its smaller scantling for equal strength compared with iron; and further to strengthen the steamer longitudinally, two bulkheads to run from bow to stern about 6ft. from her sides, also to be divided into five compartments by thwart bulkheads above the longitudinal bulkheads, two trusses rising about 8ft. above the deck at midship, with stancheons spaced about 10ft. apart; the trusses to be of the T section, and the stancheons tubes for lightness. For the third qualifications, high-pressure engines and boilers of the locomotive class, using steel for piston-rods, connecting rods, and valve gear, and homogenous metal in the framing, shafts, and cranks, cast iron only being used for the cylinders and valve casing; in fact, wherever the superior metal can be used it should be adopted.

The description of vessels would be a steamer with two barges lashed alongside, or in going through the creeks or narrows to be towed astern. Dimensions for steamers to be, length 210ft., beam 30ft., and depth of hold 5ft., with a co-efficient of fineness at 3ft. draught of ·72. This will look full, but it must be remembered that it was nearly all taken from the two ends, the body of the vessel for about two-thirds her length being nearly a square box.

The barges to be, length 150ft., beam 22ft., and depth of hold 5ft., co-efficient of fineness ·75, divided into three compartments with thwart bulkheads. The decks to be of the same material as the vessel.

A steamer of the above dimensions would displace at 3ft. draught 432 tons. The hull and fittings I calculate would be 185 tons; engines, boilers, and water, 110 tons; this would leave for cargo and fuel 137 tons, allowing 37 tons for fuel, which would be ample for her longest run between stations. This would leave 100 tons for dead weight cargo of steamer.

Each barge would displace 206 tons at 3ft. draught. Weight of each 56 tons, leaving 150 tons for cargo to each barge. This gives for steamer and two barges 400 tons of cargo, which, at the present rate of freight, 1*d*. per ton per mile for up freight, and ½*d*. per ton per mile for down freight, should leave a very good return upon the capital laid out, after clearing working expenses.

I am quite aware that fullness increases the weight of the vessel herself, and tends to diminish the speed; but I wish to make her an owner's vessel, to carry a fair load upon the least draught of water. Now, I think you will agree with me that fullness has something to do in this respect, and as I do not think it advisible to make her longer for handiness in working in the river, the only other resource would be giving her more beam. This, I think, would increase the resistance as much as a little fullness in the vessel herself. Further, she is finer than any of the steamers on the river when I left. I believe the Oriental Inland Steam Navigation Company got one or two boats on the model of your Clyde river steamers; but what was the consequence? they drew 4ft. 6in., and were therefore useless for a part of the year. Light draught and to carry a fair cargo is indispensable. Speed, such as your Rothesay boats, is not wanted; 11 or 12 miles an hour would be ample, and with 600 indicated horse power, I think would be realised easily, even taking into account the fullness.

The boats of the Government, with very bluff bows, and 1½ft. more draught of water, the midships immersed area being 126ft. for steamer and barge, made 8 miles an hour with about 400 indicated horse power. I am taking the indicated horse-power at 2¼ times the nominal, and I am sure they did not exceed, if they came up to that; and again the *Sutlej*, the altered train steamer, with one barge, went through Sukkur Pass at the height of the inundation, the current at the time said to be 8 miles, and the speed of the vessel 1¼ miles per hour. Now, I have uniformly found that a steamer will go in still water more than the current and speed of ship added together. Some allowance must be made for shallow water; but the Indus is neither a shallow nor a narrow river generally: in some parts it is both, though not at the same place, and of course you must have vessels to pass these parts.

The expense of such a class of steamers would be about £150 per voyage for fuel, wages, and stores. The fuel is the heavy item, and as the demand for wood increases, there is no doubt the price will also rise; but as coal has been found in Scinde and also in the Punjab, that will soon become the fuel to be used. English coal might be used for the lower stations of the river, but to transport it to the upper stations would be very expensive, at least £7 per ton for the upper stations before being put on board the steamers. You must not understand that I think that one steamer and barges would be a profitable investment. The expense of management, agencies, and fuel stations would be too heavy; these would be the same whether there was one or a dozen of steamers sailing from each end weekly, or at least once in ten days; for this, four or six steamers and barges would be wanted.

The trade of the river is in a transition state, increasing every year to a large extent. The principal up freight is general merchandise, piece goods, beer, and metals; the down freight is raw and manufactured silks, wool, indigo, and various kinds of oil seeds, to which I hope soon will be added cotton.

The passenger traffic is mostly native, and though not yet so numerous as on the Clyde in the summer time, it has increased greatly, and will continue to increase as facilities are afforded them, for they are a very migratory race. Cabin accommodation is not required to any large extent: the natives are all deck passengers, and even the few Europeans that travel prefer what is called a first-class deck passage. This simply means to be victualled in the cabin and sleep on deck.

No bulwarks are required for the steamers or barges, but a light rail and netting, with awning stancheons fitted for double awnings, with a space between the awnings of about 18in.; the lower awning to have hanging curtains all round.

The engines, as I formerly stated, should be high-pressure of the simplest construction. I think diagonal cylinders of about 26in. diameter and 5ft. stroke, working steam at 100lbs. per square inch, and cutting off at half-stroke, with a piston speed of 350ft. per minute, would be a suitable size; and although they take up a large space in the vessel, they distribute the strain to an equal extent. As the water of the Indus is very muddy, a filter is indispensable for the feed water. One placed in the bilge of the vessel, with a steam-pipe attached to reverse the current at pleasure, and clean it out, would be suitable.

The boilers to be of the locomotive class, suitable for wood fuel; the furnace doors large, Scinde wood being in crooked billets, generally supplied in from 3 to 4ft. lengths. The funnel to have a spark catcher similar to those on the American locomotives; the ash pans to be used as feed heaters, with safety escape valve connected to each.

REVIEWS AND NOTICES OF NEW BOOKS.

A Course of Geometrical Drawing.—Part I., revised edition, containing Practical Geometry, including the use of Drawing instruments, the Construction and use of Scales, Orthographic Projection and elementary descriptive Geometry. Part II., containing Orthographic, Geometric, and Perspective Projection, including the principles of shading and the practice of making finished drawings, designed as a text-book for the use of candidates preparing in Geometrical Drawing for the different Public Examinations, and to meet the wants of the Engineer, the Architect, and the Builder, &c. By W. S. BINNS, M.C.P. London: John Weale.

Mr. Binns has published, in a single volume, the two little treatises issued by him as aids to the student in Geometrical Drawing. The result is highly satisfactory, for the author has succeeded thoroughly in producing a text-book, which, for practical utility and simplicity, is not excelled by any work of the kind, either in the English or French languages, addressed to the classes for whom the present volume is intended.

The first part is written and arranged in a style suited to beginners, the second part to the more advanced students. The collection of problems is large, and the selection excellent. Mr. Binns's book deserves to be extensively known and patronised.

Book-keeping, its Use and Necessity: with Hints for the Tyro in the Government in Public Official Life. BY J. T. WARD. 8vo., 1*s.*: London: the Author.

We confess to knowing but little of the science of commercial book-keeping; but Mr. Ward has strung together eleven short essays in the form of "letters on book-keeping," containing some admirable hints, which would, if read and attended to by book-keepers and others engaged in counting house duties, result in advantage to themselves and their employers.

A Record of the Progress of Modern Engineering: comprising Civil, Mechanical, Marine, Hydraulic, Railway, Bridge, and other Engineering works. Edited by WM. HUMBER, Assoc. Inst. C.E., and Member Inst. M.E. Imperial 4to. Plates. London: E. and F. N. Spon. Parts 6, 7, and 8.

We must confess our satisfaction at the great improvement effected by Mr. Humber, during the progress through the press of this important work. As a *portefeuille* of examples of works of railway engineering construction its practical value is now becoming more perfectly developed.

Thus far Mr. Humber has chiefly, if not entirely, confined himself to recording the progress of that branch of modern engineering which is connected with the construction of railways, at home and abroad; and some really admirable illustrations have been given, more particularly in the later parts. As the publication of the work progresses—like good wine—it improves. The plates are all of large size, and the illustrations are drawn to scales sufficiently extensive for reproduction by the practical man who may require to adapt to his own use any of those public works which have been selected for publication by Mr. Humber.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

To the Editor of The Artizan.

Sir,—I read with interest the remarks of your correspondent Mr. Grier;* and feel that his experiment on the said law of motion, though bringing no result, is still useful to a teacher, or learner, as another illustration of the general truth. I take the liberty of forwarding the accompanying short paper, not as containing anything new, but as expressing, in a simpler form than I have seen it elsewhere put, this important truth of science. With respect to the cube theory, a principle so useful and so true in practice, saying nothing of its recognition by such respectable authority, cannot be summarily disposed of as a clumsy approximation to the imperfection of mechanical appliances, but must be met by careful enquiry and examination, the only certain way to improvement.

By the said law of motion, let P be a pressure exerted on a body whose mass is M, and P′ another pressure on the same body, then,

$$\text{moving force of } \frac{P}{M} : \text{moving force of } \frac{P'}{M} :: P : P'.$$

Now, if P′ equal any multiple of P, say 2 P, and the law is expressed in the way your correspondent states it, we get something like following :—

To move a body mass, M, through a given space, if we wish to double the velocity, we must double the pressure.

But the given space will be passed over in half the time as before, and, therefore, if the motion be continued as long as at first, double the space will have to be passed over. And taking the case of resistance to motion in a fluid, double the number of particles will have to be displaced, thus requiring double the power while each particle also requires twice as much power to move it as before, whence, the ratio of the resistances will be as $1^2 : 2^2$. And for any value as P of P′, the ratio will be as $1^2 : 2^2$.

I am, Sir, your obedient servant,

Portsea, August 23, 1863. H. W. G.

Obituary.

THE LATE MR. JOSHUA FIELD, F.R.S.

It is with great regret we have to announce the death of Mr. Joshua Field, of the firm of Messrs. Maudslay, Sons, and Field.

This eminent engineer was born in the year 1787, and died after a few weeks' illness at his residence, Balham Hill House, Surrey, on Monday, 11th ult. It has fallen to the lot of few men to have been engaged for so many years in the active pursuit of mechanical engineering, or to have attained to so distinguished a position as Mr. Field occupied in his profession, which he may be said to have reached by the momentum of natural talent, multiplied by untiring industry.

He was selected when still a young man by the late Henry Maudslay, to co-operate in bringing mechanical tools to the precision which laid the foundation of that excellence of workmanship, which is now so distinguished a characteristic of English engineering. In marine engines and boilers he was especially successful. The impetus given to steam navigation in 1838, by attention to detail in design and high standard of workmanship in execution of the machinery of the Great Western steamship, was surprising, and laid the foundation of the high reputation enjoyed by his firm in that important department of engineering. In nearly all other branches he was equally successful, and was consulted as a safe authority by many eminent men.

His public character, however, was eclipsed by the virtues of his private life, of which we will only remark that kindness and modesty of deportment, open-hearted liberality, a cheerful and happy disposition, were combined with a sincere but unobtrusive piety.

His remains were accompanied to Norwood Cemetery, on the 18th ult., by a large concourse of private and professional friends, including a large number of workmen from the manufactory at Lambeth.

Mr. Field has left a widow, one daughter, and four sons, two of whom were in partnership with him and Messrs. Maudslays.

* [Mr. Grier's communication, though given in the body of The Artizan of last month, should have appeared in its proper place under the head of Correspondence.—Ed. Artizan.]

NOTICES TO CORRESPONDENTS.

D. B. (Govan).—We believe the model in question was produced by the method of development suggested by Mr. Thomas Moy at a meeting of the British Association for the Advancement of Science in 1856 or 1857. If you refer to the volumes of The Artizan for the years 1856 to 1860 you will find the information you require, and much that is highly interesting. See a diagram at page 286 (vol. 15, for 1857), and others.

G. H. (Newcastle-on-Tyne).—There is nothing new in the idea. The trunks of steam engine pistons have been made both elliptic and of parallelogram form in section. You had better stick to the cylindrical form.

Engine-Tenter.—The cylinder might have been injured through the presence of grit and hard dirty matter. The course suggested by you is most improbable, as, if you looked after your engine ever so superficially, you must have observed the wearing away of the piston rod gland, and the constant leakage which would occur.

Workman.—Calculate working load at one-eighth of breaking strain. Your question is incomplete. Send a sketch of what you propose, state the purpose for which the engine is intended to be used, and the greatest speed at which it is intended to work, and we will give the exact information. Get Professor Rankine's work on Engineering, published by Griffin and Co., Paternoster-row. Mr. Weale, of Holborn, has published several books which it is evident you would find useful.

Beta.—The "multi-puncher," to which no doubt you refer, was designed and patented by Mr. R. Roberts, of Manchester, and was erected at the Canada Works, Birkenhead, where, by its use, it has, we believe, repaid its cost very many times. The other machine is manufactured by Messrs. Collier and Co., of Salford.

M. de Britto.—The engines were constructed by Messrs. Humphrys, Tennant, and Co., of Deptford. The frigate was, we think, built by Messrs. Wigram and Co., Blackwall.

R. R.—Clifford's boat lowering apparatus is the one we recommend, in the most perfect belief as to its great superiority.

S. (Calcutta).—The locomotives were designed by Mr. John Kershaw, C.E., of Duke-street, Westminster, London; and built by Messrs. Sharp, Stewart, and Co., of Manchester.

"120° in the Engine-room."—Cover your cylinders, steam pipes, and other hot surfaces, with Spencer's patent composition for preventing the radiation of heat; it is far better than the felt and wood usually employed, and much cheaper, too; "it sticks like wax." Mr. James Spence, of Portsmouth Dockyard, is the patentee.

D. (Dundee).—Messrs. Rennie have sent out to Spain such a floating dock for the Spanish Government.

Phillip "N. W."—If your measurement of the fine steel music wire is accurate, the strength, according to our calculation, is equal to about 182 or 184 tons per square inch. How was it hardened and drawn? Send some pieces for our inspection and experiment, as we have by us the apparatus we employed in making the experiments in connection with the great music wire patent cause, Horsfall *v.* Smith, tried at Guildhall, London, about five years ago.

Ferro-Carrill.—Repeat your first inquiry more distinctly. The Bessemer process *is* in successful working, and the Bessemer steel is being extensively used in rolling rails for railways. The greatly increased wear and tear, and the comparative badness of the iron rails rolled within the last few years in Wales, combined to render the employment of steel necessary. We do not know anything of the firm named by you, and do not desire to do so.

X. X.—Mr. Fairbairn's experiments are the most recent. For a report of the very complete set of experiments on the strengths of iron and steel by Mr. D. Kirkaldy, of Glasgow, refer to The Artizan for 1861; but he has since published the two series of experiments, &c., in a volume, the second edition of which was noticed in The Artizan for July, 1863.

J. G. (Edinburgh).—We should like to know *what heat* you employed when the prussiate of potash was applied, as a proper treatment with prussiate of potash should certainly harden the metal.

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Bovill *v.* the Brighton and Uckfield Railway Company.—Mr. Lush, Q.C., and Mr. Watkin Williams were for the plaintiff; Mr. Hawkins, Q.C., Mr. Waller, of the equity bar (specially retained), and Sir G. Honeyman, were for the defendants. The plaintiff in this case is the well-known engineer. He sued the defendants upon an agreement by which he was engaged to negociate and conclude a contract for them with Sir Morton Peto and Mr. Betts for the construction of the defendant's line for £215,000, for concluding which he was to be paid a commission of £500, and the breach of contract complained of was that, after he had concluded the contract with Messrs. Peto and Betts, the defendants repudiated his authority to enter into it for them, and refused to complete, and thus prevented him from earning his commission. After the pleadings had been opened by Mr. Watkin Williams, the counsel on each side entered into a negociation, the result of which was that the defendants submitted to a verdict for £500.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Aerial Locomotion.—On the subject of such movement by means of screw propellers, M. Babinet expresses himself as follows:—"MM. Nadar and de la Landelle have constructed a little apparatus which receives its propulsion by means of springs, and which rises in the air, springs and all, without any other action. These little engines are therefore perfectly automotive, and find a fulcrum in the air. The form of the screw-propellors remains to be studied, as well as the nature of the steam-engine which is to provide the force of locomotion; but, as a large model is always, in a mechanical point of view, more advantageous than a small apparatus, we may here boldly say that if a mouse has been carried up into the air, it will be much more easy to transport an elephant. That is a question of money and technology. Hence we may warrant the success of aerial navigation within the limits of possibility; that is, we shall never be able to go against violent winds which the strongest birds cannot resist. As to the exclusion of air-balloons, which MM. Nadar and de la Landelle proscribe, natural philosophers have long considered the directing of balloons lighter than air as a problem which is not only insoluble, but absurd. As to screw-propellers, they should be possessed of great velocity, but a great many may be applied so as to work together. A spring will give the propellers a regular motion, and the steam-engine, made of thin metal, is only to keep the spring constantly tight. This spring will act as a fly for the motive power. As to the necessary velocity, I may say that on the Seine, a screw steamer, the screw of which had a distance of a metre between the threads, and which might have performed a kilometre in 800 revolutions, only went 200 metres when it turned slowly, whereas it went 800 metres when turned fast. The advantageous effect of rapidity consists in this, that the air, obliged to yield to the impulse, has not time to escape from under the screw, and is strongly compressed. For this same reason a parachute descends slowly, because, to escape from under it, the air must fetch a considerable compass, which is effected at the expense of the descent."

New Coating for Iron-plated Vessels.—Some experiments with a new method for coating the iron plates of vessels, to preserve them from oxidation and fouling, have been so satisfactory that the Admiralty has ordered the whole of the armour-plates of the cupola ship *Royal Sovereign* to be thus covered. The material, which has been introduced by Messrs. H. J. Hall and Co., is termed "Brown's vitreous sheathing," and consists of a surface of glass fused upon small plates of iron, sufficiently to be to a certain extent flexible which are applied to the ship by a new adhesive process, and which have been ascertained to be capable of resisting all ordinary contingencies from pressure or abrasion. Compared with other metallic coating substances, this sheathing is economical, the cost being 1s. 6d. per square foot. The Peninsular and Oriental Company have tested the invention, and a trial of it has been ordered by the French Emperor at Cherbourg.

Application of Steel.—Experiments have been made in Prussia to ascertain the capabilities and advantages of cast-steel steam boilers. Two cylindrical egg-end boilers, one of steel, the other of wrought-iron, were compared, and after working six months were examined. They were 30ft. long, and 4ft. in diameter; the steel boiler plate was ⅜in. thick. It was tried by the hyraulic test, to a pressure of 195lbs. per square inch, without altering in shape or showing leakage. After working six months, the cast-steel plates were found quite unaffected, and had a remarkably small amount of incrustation as compared with the other boiler. The former generated 25 per cent. more steam than the latter. Another examination has recently been made, the boiler having been in use for a year and a half. The steel boiler was found in excellent condition. It appeared that it evaporated 11·66 cubic feet per hour, against 9·37 by the common boiler, with about the same expenditure of fuel.

Telegraphic Wire.—Telegraphic wire has become rather an important article of commerce. During the last ten years it has been exported to the following values:—1853, £72,584; 1854, £81,566; 1855, £163,737; 1856, £89,076; 1857, £302,216; 1858, £224,708; 1859, £742,306; 1860, £251,712; 1861, £214,441; 1862, £321,044. We have thus in the ten years an aggregate export of the value of £2,474,410.

NAVAL ENGINEERING.

The "Wye," iron screw storeship, 700 tons, 100 horse-power, which has recently received extensive repairs, and been fitted with new boilers built by Messrs. Penney Brothers, at the hands of the operatives of Sheerness Dockyard, has undergone her trial at the measured mile off Maplin Sands. The average speed attained was 9·591 knots, vacuum 27in.; revolutions, maximum 71, mean 70·16 per minute; pressure of steam, 15lb.; draught of water—forward, 10ft. 4in.; aft. 12ft. 6in. The vessel is fitted with Griffith's screw, pitch 16ft., diameter, 12ft. 6in.; and the indicated horse-power of her engines is 540. The trial was considered very successful, and the vessel will shortly leave for the west coast of Africa as a storeship.

Admiralty Pilot Boat.—A new pilot lifeboat 22ft. in length, built by the shipwright department of Woolwich Dockyard, by order of the Board of Admiralty, from designs furnished by Mr. Turner, the master shipwright of the yard, has recently arrived at Devonport. The boat, which is self-righting, cannot sink by reason of its buoyancy effected by air cases and open tubes through the bottom. If turned over and filled with water it will right itself in about 15 seconds. The air cases are movable, so as to be easily taken out for painting and inspection, with the exception of the long middle trunk, through which the open tubes pass, and which is fastened to the boat for the purpose of strengthening her lengthways. Should any water penetrate into the trunk by any unforeseen mishap it can be cleared out readily by the removal of some metal screws in the lower part of the sides of the trunk. But should the boat by any possibility ship a sea, filling her entirely, it would run out in 15 seconds. If a small quantity of water should find its way into the joints of the cases they can be emptied by taking up the short piece of midship bottom board and the case under each side. The sailing qualities of the lifeboat were tested at various times in the river, preparatory to her being despatched from Woolwich yard. On one occasion during a high wind, when all her sails were set she continued her course buoyantly with her gunwale 12in. under water.

The "Onondaga," American Iron-clad Steamer, has been recently launched from the Continental works, Greenpoint, U.S. The *Onondaga* is 230ft. long, 52ft. beam, and 15ft. deep. She is unlike the Monitors afloat in some respects, having side armour, consisting of 1½in. in thickness, of rolled plate iron, to which is bolted a hammered iron plate 4½in. thick; to this is fastened solid locust timbers, 13in. deep, and over this a guard of plate iron, 1in. thick, is securely bolted. The deck is of iron, 2in. thick, rivetted to iron beams, and to have an ash planking on this deck 5in. thick. There will be two turrets, each 21ft. in diameter, 9ft. high, made of 6in. rivetted plate iron, and over this a hammered iron plate is fastened, making altogether 12½in. of iron in thickness. A pilot house, 6ft. diameter, inside, is placed over the forward turret, made in the same general manner as the turrets. Her motive power consists of two propeller wheels, one under each counter, both driven by a pair of engines, 30in. bore, and 18in. stroke of piston, supplied with steam from four tubular boilers.

Iron Frigate on Mr. Reed's Principle.—The first of a new description of iron frigates to be constructed according to Mr. Reed's plan is to be laid down at Chatham as soon as the resources of that establishment will permit. The new frigate is to be named the *Bellerophon*, and although somewhat smaller than of the iron ships of the *Achilles* class, is intended to be superior, both for offensive and defensive purposes, to any of the iron steamers now afloat, while, from the several improvements already effected in iron shipbuilding, she is expected to be a first-rate sea-going ship. The *Bellerophon* will be a little over 200ft. in length, or about 80ft. less than the *Achilles*, and with a breadth of beam of 50ft. She is only intended to mount 12 guns, but these will be of the most powerful description used in the service. The vessel will be incased in iron armour-plating of 5½in. in thickness in her most exposed parts, and 4½in. in other portions of the vessel. She will be fitted with engines of 1200 horse-power, in order to enable her to steam 15 knots an hour.

Trial Trip of the "Recruit."—The iron paddlewheel steamer *Recruit*, 6, 150-horse power, fitted at Chatham for the coast of Africa, was taken to the Maplin Sands on the 19th ult., for the purpose of making an official trial of her speed at her sea-going trim, with all her Armstrong and other guns, stores, &c., on board. On the occasion of her former trial, on the 9th ult., the *Recruit*, after one break down, attained an average speed of 10·508 knots per hour in six runs at full boiler power. In four runs, with half of the boilers cut off, the average speed was 8·652 knots, the paddlewheels making 31 revolutions per minute. Her mean draught was eight feet. Since her former trial all her guns, stores, &c., have been put on board. With all her stores on board the *Recruit* lies like a log in the water, and at times during the trial the sea washed over her sponsons in a manner which was rather alarming. Only two runs were made at the measured mile, when the speed attained was only about five knots an hour. After steaming twice over the Maplins, the performance of the vessel was found to be in the highest degree unsatisfactory. Captain Hall consequently determined on abandoning the trial, and the vessel was brought back to harbour, a very strong report of the unfavourable result of the trial being at once forwarded to the Admiralty.

A New War Vessel.—A new war vessel is in course of construction at Cincinnati, U.S. This strange craft is known as *Elliott's War Turtle*. It is shaped like a large punch-bowl, with the propeller in the form of a turbine wheel, placed at the bottom, and so arranged as to take water in through eight radial tubes, which may be opened or closed by valves; the said tubes connecting with the propeller and outer edge or hull of the vessel. The propeller passes the water downward from its cylinder and revolves always in the same direction, and when the vessel is to be moved forward in any direction, one or more of the valves is opened, thereby relieving the pressure on that side, while the pressure still remains on the opposite side to propel the vessel. The turret is very similar in appearance to those on the Monitors, but is built fixedly and firmly on the top of the vessel, and lined inside with heavy timber. It revolves with the boat by the action of the water upon the rudders placed in the mouth of the radial tubes. It mounts four guns.

The Trial Trip of the "Orontes" troopship, Cap. W. H. Hire, took place on the 12th ult. at the measured mile in Stokes Bay, under the supervision of Captain H. Broadhead. Mr. Langdon, who represented the firm of Messrs. J. Watt and Co., the makers of the engines, was also on board. She made six runs at full speed, with steam pressure at 22lb., vacuum 22in., and 60 revolutions of engines, giving an average of 12·352 knots; and at half-boiler power, with steam pressure at 25lb., vacuum 25in., and 46·5 revolutions of engines, giving an average speed of 9·755 knots. She then made the circle, with helm a-port, at full power, in 9min. 24sec., and at half-power, with helm a-port, in 11min. 1sec.; and with helm a-starboard at full power, the circle was made in 9min., and at half-power in 9min. 28sec. The half circle was made, at full power and helm a-port 9min. 26sec., and at half-power 4min. 45sec.; and with helm a-starboard, full power, 9min. 17sec.; half-power, 4min. 41sec. Her draught of water was—forward, 21ft. 6in.; aft, 22ft. 6in. The trial was considered very satisfactory.

The "Lord Warden."—This armour clad frigate, like the *Royal Oak*, the last vessel built on the same slip, will be constructed almost entirely of foreign oak. In the construction of the *Lord Warden* several important improvements will be effected by Mr. Reed, from whose designs she is to be built. The plan of lessening the thickness of the armour plating on the bow and the stern, hitherto adopted in this class of vessel, is to be discarded in the case of the *Lord Warden*, and the Admiralty have decided on encasing her in one uniform thickness of armour-plates; so that she will have the same description of plates on her stem as on her broadsides, the use to which it is intended to apply her rendering it most important that her bow should be carefully protected and of enormous strength. Another important feature in the *Lord Warden* will be the placing of a powerful battery of guns at her bow, in which she will differ from all other vessels of war now afloat. This battery will be so placed as to enable the guns to be fired straight ahead, while the solid, iron-plated bow will be carried up sufficiently high to form a sort of tower, in which the guns will be placed. As the *Lord Warden* is designed to steam at least 13 knots an hour, this powerful bow battery will prove of the utmost value when chasing a hostile vessel. In order to support this additional weight thrown on the bow, the body of the frigate will be built out into a long projecting prow, several feet below the water, and this will serve a twofold advantage—that of giving increased buoyancy to the frigate, and at the same time furnishing her with a most powerful means of destruction, the *Lord Warden* being, in this respect, different to every other vessel afloat. The extremity of the prow wil be furnished with a huge steel stem, shaped somewhat like a

cleaver, and this formidable weapon will, it is anticipated, cut completely through a hostile ship when used as a ram, as, from the enormous size and momentum of a vessel of the *Lord Warden's* dimensions, one or at the most, two blows would be sufficient to sink the largest vessel afloat. The ports in the new frigate will be more elevated above the water line, and the armour-plating carried lower down than in any other vessel of the class, notwithstanding which provision is made for a high rate of speed.

THE RUSSIAN IRON-CLAD BATTERY "PERVENITZ" left Gravesend on the 8th ult., for Cronstadt, under steam. On arriving off the Maplin Sands she was tried at the measured mile, and realised a mean speed of eight knots, with 80 revolutions of her engines, the maximum number of revolutions being 110. She completed a full circle in five minutes fifteen seconds, and was found to be under the most perfect command of the helm.

THE PADDLE-WHEEL STEAMER "SALAMIS," 250-horse power, was taken out of Chatham harbour on the 1st ult., for the purpose of making her first trial of speed on the completion of the fitting of her engines. The engines were in charge of Mr. Ravenhill, of the firm of Ravenhill, Salkeld and Co., by whom they have been manufactured. With 180 tons of coal on board, the *Salamis* drew 9ft. 11in. aft, and 9ft. 6in. forward; or, in other words, she was on a nearly even keel. She is fitted with Morgan's patent feathering floats, and her engines are fitted with all the modern improvements. The diameter of the cylinders is 61in., and the length of stroke 4ft. 6in. She has four boilers in which the steam is generated, and 12 furnaces, in addition to which she is fitted with superheated steam apparatus. The vessel was taken considerably past the Mouse light, as far as the entrance to the Downs, when with full boiler power the speed of the vessel was very satisfactory. Two runs were made at the measured mile, Maplin sands, at about three-quarter speed, and, notwithstanding that the paddlewheels were only making an average of 34 revolutions per minute, the vessel attained an average speed of close upon 15 knots per hour. With an improved trim and with 38 revolutions of the paddlewheels there is little doubt that she will attain an average of 16 knots per hour, which is exceedingly satisfactory. During the trial her engines worked with remarkable smoothness, and, notwithstanding that it was the first occasion of their being tried, there was no priming and no occasion to stop the machinery on account of hot bearings. The second official trial of the *Salamis* took place on the 21st ult., at the measured mile, off the Maplin Sands. The wind at the time of the trial was blowing from the westward with a force of three, and there was a moderate sea on. Six runs were taken at full boiler power, with the following results:—In the first run the time was 4m. 34s., the speed in knots 13·139, the pressure of steam 26lb., and the number of revolutions of engines 38; in the second run the time was 3m. 36s., the speed in knots 16·667, the pressure of steam 26lb., and the number of revolutions of engines 39; in the third run the time was 4m. 36s., the speed in knots 13·043, the pressure of steam 26lb., and the number of revolutions 38½; in the fourth run the time was 3m. 35s., the speed in knots 16·744, the pressure of steam 26lb., and the number of revolutions of engines 37½; in the fifth run the speed was 4m. 38s., the speed in knots 12·95, the pressure of steam 26lb., and the number of revolutions of engines 38; in the last run the time was 3m. 40s., the speed in knots 16·364, the pressure of steam 26lb., and the number of revolutions of engines 37. The average speed of the six runs was 14·843 knots, equal to 17¼ statute miles per hour. This result was in the highest degree satisfactory. The *Salamis* afterwards made four runs at half-boiler power, with the following results:—In the first run the time was 5m. 12s., the speed in knots 11·538, the number of revolutions 38, the pressure of steam 26lb.; in the second run the time was 4m. 22s., the speed in knots 13·74, the number of revolutions 30, and the pressure of steam 26lb.; in the third run the time was 5m. 9s., the speed in knots 11·65, the number of revolutions 30½, and the pressure of steam 26lb.; in the fourth run the time was 4m. 23s., the speed in knots 13·688, the number of revolutions 30., and the pressure of steam 26lb. The mean average speed of the four runs was 12·648 knots. At the close of the official runs some experiments were made in making the circle. At full speed the complete circle was made in 5m. 10s., the rudder being brought over to an angle of 35 deg. by three men with three and a half turns of the wheel. At half speed the complete circle was made in 5m. 29s. With the helm hard a-port, the half circle was made in 2m. 39s., and with the helm hard a-starboard the half circle was accomplished in 2m. 23s., the rudder in each case being over at an angle of 30 deg., and the diameter of the circle being about three times the vessel's length. At half speed, with the helm at port, the half circle was made in 2m. 40s., and with the helm at starboard in 2m. 53s., with three men at the wheel, the rudder, which was at an angle of 30½ deg., being brought over in three turns. The engines from full speed were stopped dead in 13 sec. from the word being given from the bridge, and when going astern the engines were stopped in 3 sec., and turned ahead in 3 sec. From full speed ahead the engines were stopped and started astern in 40 sec. The boilers generated a full supply of steam, and not the slightest appearance of hot bearings was indicated. The engines worked with the greatest smoothness and regularity, and the diagrams of the expansion cards were exceedingly favourable. During the trials the average temperature was 82 deg. in the engine-room, 92 deg. in the after stokehole, and 94 deg. in the forward stokehole.

THE TRIAL TRIP OF THE "AURORA," TWIN SCREW STEAMER, took place on the 25th ult. The *Aurora*, built and engined by Messrs. J. and W. Dudgeon, of Millwall, is an iron vessel, 165ft. in length, with a beam of 23ft., a depth of 13ft. 6in., an area of midship section of 150 square feet, and a displacement of 400 tons. Her engines have a collective nominal power of 120 horse, and drive two three-bladed screws, each independently of the other, 7ft. in diameter, and with a pitch of 14ft. 6in. The cylinders have a diameter of 26in., and a 21in. stroke. The *Aurora* is a smart-looking vessel, with much finer lines forward and aft than were possessed by either of her predecessors. She carries two short masts, rigged for fore and aft canvass, and altogether has the appearance of a thorough steam clipper. Her draught of water at starting was 7ft. 3in. aft, and 5ft. 3in. forward. The following are the particulars of the trial.—In running past the measured mile in the Lower Hope, with the engines going 103 to 105 revolutions, she was timed and found to go over the ground in 4 min. 8 sec., giving the vessel a speed of 14·516 knots. At 1·30 p.m., the *Aurora* was approaching the Nore Light vessel, the engines averaging 120 revolutions, with 27lb. of steam and a vacuum of 25in., and every part working with the greatest possible smoothness. At 1.37 the Nore was passed, the distance from Tilbury, 20 nautical miles, having been done in 1 hour and 17 minutes. From the Nore to the Mouse Light the vessel continued her course, the wind still fresh from the some quarter, and the movement of the water which necessarily accompanied it giving the vessel, from her light draught and hold upon the water, sufficient "roll" to detract from the efficient acting of her only just submerged screws. Notwithstanding this disadvantage, however, she ran past the "mile" on the Maplin Sands in 4 min. 10 sec., giving a speed of 14·4 knots, it being now slack water, and the tide of little moment either way, and accomplished the distance to the Mouse Light in 2 hours, 5 min., 22 sec., having been 28 min., 23 sec. from the Nore—8 nautical miles. During the latter part of the run down, a small jib had been set to steady the vessel, but no other help was given by the vessel's canvass to her engines in attaining this somewhat extraordinary rate of speed. From the Mouse the *Aurora* was run out between the Maplin and the Barrow as far as the Swin Light. On reaching the Swin the vessel's head was brought round and laid homeward, it having been decided not to lengthen the trial by making circles, &c. From the Mouse to the Nore in the teeth of a strong gale, the run was made in 33 min. 15 sec., the time being at the measured mile 4 min. 25 sec. Southend was passed at 4 hours 15 min., and about two miles a head was seen the *Sea Swallow*, one of the fastest paddle steamers on the Thames, plying between London, Southend, and Sheerness, and a hot chase ensued, the *Aurora* eventually passing the *Sea Swallow* at 4 hours 40m., in the midst of a heavy squall of wind and rain, and subsequently during the run up to Blackwall passing everything under steam she came across. Gravesend was passed at 5 hours 15 min., the engines making on an average 127 revolutions, and Blackwall pier, the closing point of the *Aurora's* day's work, being reached in 1 hour 7 min., the distance being 29 miles. The principle of the adaptation of twin screws to ships of war has been so far acknowledged in its importance by the Admiralty that their lordships have given Messrs. Dudgeon an order to construct a small vessel, which shall combine in their most efficient form the double-screw principle.

NAVAL APPOINTMENTS.—The following appointments have taken place since our last:—W. Stacey, engineer, and W. Crow and J. Glaysher, assistant-engineers, to the *Recruit*; W. Hardie, engineer to the *Fisgard*, as supernumerary; A. Atken, supernumerary in the *Asia*, promoted to Engineers; J. Elwess and J. Rogers, supernumeraries in the *Asia*, promoted to first-class Assistant-Engineers; E. Brown, Engineer to the *Asia*, for the *Albacore*; W. Herd and J. Davies, Assistant-Engineers to the *Hawke*; G. R. Bissaker, R. Ditchburn, J. Barr, G. Murray, S. Scott (B), J. Hughesden, T. S. Blyth, F. M. C. Richards, Assistant-Engineers to the *Marlborough*, as supernumeraries for disposal; J. M. Page, first-class Assistant-Engineers to the *Orontes*; T. Scott (A), confirmed as first-class Assistant-Engineer in the *Pembroke*; W. Rumble, first-class Assistant-Engineer to the *Cumberland*, for the *Wizard*; A. Brown, promoted to Acting First-class Assistant-Engineer in the *Galatea*; R. Jago, Second-class Assistant-Engineer, to the *Jago*; J. Spinks, Acting Engineer, A. Smart, First-class Assistant Engineers, and J. W. Smart, Second-class Assistant Engineer, to the *Snipe*; W. H. Brimfield, Acting First-class Assistant Engineer, to the *Wye*; D. Wilson, R. M'Caskill, A. Kennedy, M. Baird, D. Sharp, J. M'Arthur, P. Foulcs, J. Muir, E. Bennett, J. Crichton, J. Galbraith, S. M'Dougall, E. M'Leish, and J. Frazer, promoted to Assistant Engineers of the first-class; R. Crosswaite, Engineer, to the *Liverpool*; E. N. Cockrell, First-class Assistant Engineer, to the *Marlborough*; D. Wishart, in the *Brisk*, promoted to Acting First-class Assistant Engineer; H. Cook, promoted to Acting Chief Engineer; J. T. Kelly, promoted to Acting First-class Assistant Engineer.

MILITARY ENGINEERING.

BROADWELL'S BREECH-LOADING GUN.—The officers composing the Ordnance Select Committee of Woolwich Arsenal have recently been engaged at the proof butt, in order to test the Broadwell breech-loading principle, which they have had under consideration for some months past. This system consists of a peculiarly shaped self-acting gas ring or valve, which in previous trials was placed in the wedge or breech block of the gun, the position and shape of which Mr. Broadwell has since changed. The chief object of this trial was to test the advantages of the alteration. The gas ring is now fitted behind the bore, and acts against a bearing in the face of the breech block. The intention of the inventor in making this alteration appears to be to improve the facility of its application to guns not constructed expressly for its use. The issue of the trials is pronounced exceedingly satisfactory, and, according to the opinion freely given at their termination, the merits of the system were fully established, in so far, at least, as it is applicable to guns of a calibre equal to an 18-pounder, with which it had been tested. The method is now to be tested in a similar manner with the 110-pounder or larger guns. An important feature in the invention is as in the case of a common steam valve, that the greater the pressure the tighter the breech becomes closed against the escape of gas.

TESTING OF ENGLISH AND FRENCH ARMOUR PLATES.—Some interesting testing of English and French manufactured armour-plates took place at Portsmouth on the 4th and 5th ult., the practice against the plates being carried on in the usual manner, with a solid cast-iron shot, fired with 16lb. of powder, from a 95cwt. 68-pounder, at 200 yards' distance, the plates being bolted on the sides of the *Thunderer* target-ship. The plates were four in number, and comprised two manufactured by Messrs. Petin, Gaudet, and Co., of France; one of 5½in. thickness of metal, 15ft. 7in. in length, and 3ft. 4in. in breadth, and the other of 4½in. of metal, and of the same length and breadth as the 5½in. plate. The third plate was a 5½in., from the Millwall Iron Works, for the *Agincourt*, 15ft. 7in. in length, and 3ft. 5½in. in breadth; and the fourth was a 5½in. bent plate for the *Royal Sovereign's* turrets, from Messrs. Beale's. of the Parkgate Works, Yorkshire. Messrs. Beale's plate, the Millwall, and the French 4½in. were tested on the 4th ult., the French 5½in. being reserved for trial on the following day. The Millwall plate received 11 shots, and was very severely tried by overlapping shots at either end, but stood the test splendidly, and was considered a plate of superior quality. Messrs. Beale's plate was not quite so good. It showed a number of small cracks and an inclination to open from the back. Messrs. Petin Gaudet's 4½in. turned out, from its evident carelessness of manufacture, very unsatisfactory, and failed in all the conditions of contract as relating to it short-resisting powers. The metal was allowed to be good, but its manufacture was very indifferent. When examined at the close of the firing, its welding was found to be most imperfect. It had the appearance of being a rolled plate, and rolled 4½in. plates are generally finished by placing four 2½in. layers of iron, carefully cleaned from all dirt or oxide, together, and then rolling the 10in. mass down to the required 4½in. The separation of these four layers in the French plates disclosed the fact that no care had been taken in cleaning the surfaces of the four layers of iron, and consequently perfect adhesion under the rolls was impossible. Compared with the 4½in. plate supplied to the Admiralty by Petin Gaudet and Co., the one tested on this occasion was of a vastly inferior character. The result placed the three plates tested in the following order:—No. 1, Millwall Company, for *Agincourt*, 5½in.; No. 2, Beale, for *Royal Sovereign*, 5½in.; No. 3, Messrs. Petin Gaudet and Co., 4½in., a full allowance being made in this classification for the extra inch of metal in Nos. 1 and 2 plates. No. 3 received in all 15 shots, pretty well distributed, three being edge blows, and in two spots overlapping. No. 1 had a diameter of 9in., an indent of 2·1-10in., and a crack 6in. across the indent. No. 2 had an indent of 2in. and a crack 8in. long. No. 3 and 7 just impinged in the circumference of their indents upon each other, and opened cracks 12in. and 6in. long. No. 5 overlapped No. 2 4in., and drove the plate's fractured part in a circular form within the indents into the ship's side 4·6-10in., or beyond the plate's back. No. 10 overlapped upon 2 and 5 (the last mentioned), and broke the plate further into the ship's side, the area of the fracture being 16in. by 10in., measuring from centre of each blow, in a triangular form, 9in. at the base by 6in. each way. No. 13 was also attended with bad results for the plate's reputation, the shot striking full on the plate in its centre, near its upper edge, and breaking the metal away considerably to the upper edge. Messrs. Petin Gaudet's 5½in. plate on the 5th ult. was tested slowly and carefully, and came out of the trial in a most triumphant manner—in a manner which placed it on full terms of equality with the Millwall plate tried the day previous. It received 17 shots in all. The laminations showed the same faulty welding that the 4½in. of the previous day exhibited; and the success of the plates was undoubtedly owing to the superior quality of the iron, and not to its manufacture.

A SECOND TRIAL OF FRENCH ARMOUR-PLATES supplied by Messrs. Petin, Gaudet, and Co. to our Board of Admiralty, took place at Portsmouth on the 19th ult., and the results then obtained, together with a subsequent inspection of plates, prove the two tried on this occasion to be inferior in their shot-resisting powers to the two previously tried in company with the Millwall plate. Messrs. John Brown and Co. sent a plate 15ft. 6in. in length by 3ft. 7⅝in. in width, and 5½in. in thickness, for trial with the French plates, but not to compete with them. It was built up in a peculiar manner of cold blast and charcoal iron, according to a plan laid before the firm. Notwithstanding its failure, however, as a merely experimental plate, it has received a higher official classification than either of the French manufactured plates. Messrs. Petin and Gaudet's two plates were of the following dimensions:—The first was 15ft. 7in. in length by 3ft. 4in. in width

and 5½in. in thickness; and the second 15ft. 7in. in length by 3ft. 4in. in width and 4½in. in thickness. The main conditions of the contract between Messrs. Petin and Gaudet and our Admiralty are—that the 4½in. plates shall withstand three shots planted as nearly as possible in the same place without penetration being effected, and that the 5½in. plates shall resist four shots in the same manner. The 5½in. plate received in all 10 shots fairly distributed over its surface. Only in three instances were the shots overlapping, or "planted as nearly as possible in the same place," but in all three instances was the plate broken through, and penetration effected by two shots, instead of five, as per contract. Nos. 2 and 4 shots just impinged upon each other's circumference, with No. 3 in close proximity, all at the right hand end of the plate, but with no other shots near, and Nos. 2 and 4 were connected by a wide deep crack extending upwards of 15 inches. Petin and Gandet's 4½in. plate received only six shots, which, however, sufficiently decided its character. The first shot on the lower left edge exhibited a crack 7in. in length in the indent. No. 2 on the right lower edge, upon a bolt, opened the layer of metal and cracked two layers across. No. 3 shot, to the left of No. 2, opened wide fissures in the plate and drove the broken metal into the ship's side, with a large crack to the right. No. 5, in the centre of the plate, above and clear of No. 2 and 3, drove the plate into the ship's side four inches, with deep fissures in the metal. The last shot did no particular damage in the circumference of its own impact, but opened up a deep crack across a previous shot-mark 13in. in length. Penetration, it will be seen, was effected in this plate with single shots.

STEAM SHIPPING.

THE QUICKEST PASSAGE ACROSS THE ATLANTIC.—The *Scotia*, belonging to the British and North American Royal Mail Ship Company, on her recent voyage to New York, made the most extraordinarily fast run on record. She left Liverpool on the 18th of July, and made the passage to New York in nine days, two hours, and 15 minutes, beating the fastest passage before made by nine hours and 45 minutes. The two quickest passages previously made were by the *Persia*, in nine days 12 hours and 10 minutes, from Liverpool to New York; and the *Baltic*, in nine days 12 hours.

IRON SHIPBUILDING ON THE TYNE.—Recently several new iron vessels have been launched, the most conspicuous of which has been the *Atlantic*, one of a fleet of large iron tank ships building by Messrs. John Rogerson and Co., of St. Peter's, on the Tyne, to be employed in bringing petroleum from America to this country. The *Atlantic* is a sailing vessel. Her length over all is 145ft.; breadth of beam, 28½ft.; and depth, 16ft. 9in. Her bold consists of a series of iron cisterns, of a depth from deck to keel, each depth to hold a stated quantity of oil. She belongs to the Petroleum Trading Company. With the present ship the directors calculate they will make four voyages in the year, and by employing tank ships, like the *Atlantic*, they anticipate saving a considerable sum in the year. It was calculated that one ton of oil in barrels would occupy 53 cubic feet, so that a vessel that would only carry 500 tons in barrels would carry in bulk nearly 700 tons. A large screw steamer, the first built for the White Star line of Australian packets, and named the *Royal Standard*, has also been launched from the building yard of Messrs. Palmer, Brothers, and Co., of Howdon on the Tyne, during the high tides. She is 225ft. long, 40ft. beam, 27½ft. deep, her measurement is 2000 tons, and the height between decks is 7½ft. clear. The vessel is fitted up with due regard to the comfort of the passengers, special attention having been paid to ventilation. Her screw will be auxiliary, and her engines will be of 140-horse power nominal, constructed on the high-pressure surface condensing principle.

TRIAL TRIP OF THE "RANGOON."—The new screw steamship *Rangoon*, built for the Peninsular and Oriental Company, by Messrs. Samuda, of London, and commanded by Captain J. M. Rogers, had her official trial on the 4th ult., at the measured mile in Stokes Bay. She is 2014 tons burden, and her engines, which were constructed by Messrs. Humphrys and Tennant, of Deptford, are of 400 horse-power. The result of four runs on the mile were as follows:—

Run.	Time.	Knots per Hour.	Vacuum.	Revolutions.	Steam.
1	4m. 47s.	12·543	26	65	25
2	4m. 41s.	12·811	25	66	27½
3	5m. 7s.	11·726	25	66½	27½
4	4m. 26s.	13·533	26	66	27
Mean of runs		12·460	25½	66	26¾

Indicated horse-power, 1870; nominal ditto, 400. Draught of water, 17ft. 11in. forward, and 18ft. 9in. aft. Coals on board, 561 tons; water, 50; stores, 80; ballast, 100; total weight on board, 791 tons.

LAUNCHES.

LAUNCH OF THE "SYRIA."—A fine new paddle-wheel steamer, called the *Syria*, built for the Peninsular and Oriental Company, by Messrs. Day and Company, of the Northam Iron Works, Southampton, was launched on the 15th ult. She is built of iron, and upwards of 1300 tons of this metal has been used in her construction. The following are her principal dimensions—Length between perpendiculars, 312ft.; length over all, 340ft. 6in.; breadth, 36ft. 2in.; depth from base line, 29ft.; tonnage, builders' measurement, 2000. The *Syria* will be propelled by a pair of oscillating paddle engines of 450 horse-power nominal, which will be fitted with surface condensers, and other recent improvements.

THE LAUNCH OF THE "RESEARCH," 4, 1250 tons, iron-cased frigate, the first of the vessels constructed on Mr. Reed's plan, took place at Pembroke, on the 15th ult. She is intended to carry only four heavy guns, but will be entirely encased with from 4 to 4½in. armour plates.

THE LAUNCH OF THE SEA KING, from the new shipbuilding shed of Messrs. Stephens and Son, at Kelvanhaugh, recently took place. The *Sea King* is built on Messrs. Stephen's principle, of a combination of wood and iron. She has been specially constructed for the China trade, and is of 1200 tons burthen.

THE LAUNCH OF FOUR STEAMERS AT THE SAME INSTANT, on the Tyne, took place on the 15th ult. The launches were from the building yards of Messrs. Palmer Bros., at Jarrow and Howdon, which are nearly opposite each other. The vessels were the *Latona*, being the sixth of a line of steamships built for a company trading between London and Italy; the *John M'Intyre*, a large screw collier, the property of Messrs. Cory and Co., of London; the *No. 1*, built for a Rotterdam firm, and the *Europa*, intended to be employed in the passenger and goods trade between Genoa and the Island of Sardinia. Their aggregate tonnage is about 4900.

TELEGRAPHIC ENGINEERING.

THE MEDITERRANEAN EXTENSION TELEGRAPH COMPANY.—At the half-yearly meeting of this company, the following was reported:—The improvement in the past half year had been such as to render it unnecessary for the company to apply to Government for assistance under the guarantee. The directors expected that the interruption in the communication on the Malta and Alexandria line would soon be restored. The receipts for the past half year amounted to £5914 1s. 3d., as compared with £5100 for the corresponding period of last year. The time occupied in the transmission of messages between Malta and London had been considerably reduced. The report was adopted. A dividend of 8 per cent. on the preference shares, and 3 per cent. on the original shares, was agreed to, £543 being carried to the r[illegible]rve fund.

THE ELECTRIC AND INTERNATIONAL TELEGRAPH COMPANY.—The half-yearly ordinary meeting of this company has been held. The report stated that during the past half-year a considerable extension of the company's system, amounting to 754 miles of line and 2666 miles of wire, had taken place. The reduction of the tariff since June 1862, had retarded the progressive advance of the company's income. From the continental traffic a steady enlargement of business continued. The revenue of the company, from all sources, amounted to £117,210 4s. 8d., showing an increase of £14,843 4s. 8d. on the corresponding period of 1862. After making provision for the working expenses, and interest, the net surplus and profit on the six months amounted to £39,061 17s. 5d. The directors recommended a dividend of £3 10s. per cent. for the half year.

RAILWAYS.

DISTRIBUTION OF RAILWAYS.—A paper has recently been submitted to the French Academy of Sciences by M. Lalanne, showing that the apparently fortuitous distribution of railways over the surface of a large country is in reality subject to certain laws, which may be stated as follows:—1. The meshes of a network of railways, as their number increases, tend to assume a triangular form. 2. These triangles have a tendency to form groups of six each round a certain point, which, therefore, is the nucleus of a hexagon. 3. When a pentagon happens to replace the hexagon there generally is a heptagon somewhere which makes up the deficiency, so that the number six really represents the average number of lines starting from each point. 4. There are certain exceptional points, such as the capital of the country, towards which more than six lines converge; in this case the number of lines does not exceed 12. 5. In those districts where the network is still incomplete there are centres from which only three lines diverge instead of six; in that case they make equal angles with each other, thus leaving space for the three remaining lines. This strange regularity, now observable in the networks of France, England, and North America, depends upon a primordial law which Buffon calls the reason of reciprocal obstacles. Rivers, mountains, forests, or even the mere inequality in the productive force of different soils, have contributed towards the formation of these regular meshes. Among the consequences which M. Lalanne deduces from this theory of his there is this—that the distance between two agglomerations of population of the same order and near each other must be an extra multiple of the distance between the two agglomerations of an inferior order. Thus, the average distance between two capitals of departments in France is 87 kilometres; that between two contiguous *chefs-lieux d'arrondissements* is 43½ kilometres; and between two contiguous cantons, 14½ kilometres; so that the distance between two prefectures is equal to twice the distance between two sub-prefectures, six times that between two cantons, and 24 times the average distance between two communes,

RAILWAY WORK FOR THE YEAR 1862.—In the year 1862 the enormous number of 180,429,071 passengers travelled on the railways of the United Kingdom, besides 56,656 season-ticket holders, who of course all travelled very many times; and besides, also, 262,334 horses, 386,864 dogs, 3,094,183 cattle, 7,800,928 sheep, and 1,989,892 pigs. The passengers were more than in 1861 by about 7,000,000. They paid £12,295,273 for their fares. The first-class passengers paid £3,332,380; the second-class, £4,018,221; the third-class, £4,639,250. 12·80 in every hundred went first-class, 28·75 second-class, 58·45 third-class. The proportion of third-class passengers is rather increasing, and of second-class rather diminishing. Thirty-five passengers were killed (nine of them owing to their own misconduct or want of caution), and 536 were injured. This is less than half the number who lost their lives in 1861 by railway accidents. The passenger trains travelled 57,542,831 miles, and the goods trains nearly as many more. The passenger traffic supplied 47·76 per cent. of the total receipts of the companies, and the goods traffic the larger half, 52·24 per cent. The receipts from all the traffic amounted to £29,128,558, being nearly £3,000,000 more than the interest of the National Debt, and an increase of £563,000 over the receipts of 1861; but the length of line open increased from 10,865 miles at the end of 1861 to 11,551 miles at the end of 1862. The working expenditure amounted to 49 per cent., and left the net receipts £14,820,691, nearly £130,000 more than in 1861. In the year 1862 the companies paid 229,970, for law and Parliamentary expenses, £158 169 as compensation for personal injuries, £68,540 for damage and loss of goods, £375,067 for Government duty, and £596,410 for rates and taxes. It took £2,708,638 to maintain the way and works, and £1,242,714 to maintain the carriages and waggons, £3,966,005 to provide locomotive power, and £3,987,637 to conduct the traffic. The total sum raised by shares and loans reached £385,218,438 at the close of the year 1862.

RAILWAY BETWEEN MOSCOW AND SEBASTOPOL.—An ukase has been signed by the Emperor of Russia, for the construction of a railway from Moscow to Sebastopol. The line is to be 953 miles in length, the nominal capital will be £22,500,000, and the period allowed for the completion of the work is six years from the date of commencement. Sebastopol is to be made a free port.

RAILWAY ACCIDENTS

RAILWAY ACCIDENTS IN 1862.—A Parliamentary return states that during the year ending December 31, 1862, there were 216 persons killed and 600 injured in consequence of railway accidents, of which 24 deaths occurred in Ireland, 42 in Scotland, and 150 in England and Wales; the number of miles of railway open in each division respectively being 1598, 1777, and 8176. During 1861, when the total number of miles of railway open in the United Kingdom was 10,833, the number of lives lost by accidents was 284, and the number of persons injured 883. Of the 216 deaths in 1862, 26 passengers and 20 servants of contractors or the companies were killed from circumstances over which they had no control, and 9 passengers and 89 servants from want of caution on their part; 49 of the remainder were trespassers, including seven cases of suicide.

ACCIDENT TO AN EXCURSION TRAIN NEAR LYNN.—An accident occurred to an excursion train that was running from Hunstanton to Lynn, about 8·45, on the evening of the 3rd ult. As the train was proceeding at a rapid rate the engine came in contact with a bullock, which had got upon the rails. A first class and two other carriages were thrown off the line, causing the death of five of the passengers. The accident took place at Gaywood, about three miles from Lynn.

NARROW ESCAPE ON THE GREAT WESTERN RAILWAY.—The train on the Great Western line from London, due at Warwick on the 15th ult., at 6·18 p.m., did not arrive until 7. The cause of the delay was, that a few minutes after the train left Warwick; it had not proceeded more than three-quarters of a mile when the ashpan of the engine dropped out and lay across the line: the train, of course, came to a stand, and most of the passengers alighted; it was then seen that the iron composing the upper part of the pan was literally worn through, and was in almost as bad a state as it could be. Had the train got on two or three miles further, and acquired a greater velocity, the consequences of this casualty must have been very serious

ACCIDENT ON THE GREAT WESTERN RAILWAY.—On the 24th ult. an accident happened on the Great Western Railway to the 7·15 a.m. express from Birmingham to Paddington. Whilst running at full speed between Hatton and Warwick the hind axle of the engine snapped, and one of the wheels flew off. The driver feeling the jerk applied the break, but was unable to bring the train up until it had run two miles, when the engine left the metal. The carriages, however, fortunately kept on the line. The whole of the passengers escaped without the slightest injury. The escape of the train is attributable to the remaining wheel of the broken axle gliding along the longitudinal sleepers upon which the metal is laid.

BOILER EXPLOSIONS.

Manchester Association for the Prevention of Steam Boiler Explosions.—At the ordinary monthly meeting of this association held July 28th, the chief engineer presented his monthly report, of which the following is an abstract:—"During the past month there have been examined 324 engines and 450 boilers. Of the latter, 17 have been examined specially, 11 internally, 55 thoroughly, and 367 externally; in addition to which three of these boilers have been tested by hydraulic pressure. The following defects have been found in the boilers examined:—Fracture 8 (2 dangerous); corrosion, 16; safety-valves out of order, 9 (2 dangerous); water guages ditto, 21; pressure guages ditto, 8; blow-out apparatus ditto, 37; fusible plugs ditto, 2; furnaces out of shape, 4; over pressure, 1 (dangerous); deficiency of water, 1 (dangerous); blistered plates, 3; total, 110 (6 dangerous). Boilers without glass water guages, 2; without blow-out taps, 38; without back pressure valve, 41. One explosion has occurred during the last month, of a very fatal character, particulars of which are given below. No. 20 explosion, by which ten persons were killed and four others injured, occurred to an ordinary mill boiler of the two-flued 'Lancashire' class. This boiler was not under the inspection of this association. The dimensions were as follows:—Length 30ft., diameter of the shell nearly 7ft. 6in., and that of the furnace tubes—which were parallel throughout, and not strengthened by any hoops or flanges—2ft. 8in.; the thickness of the plates in the shell and tubes, seven-sixteenths, in the flat end plates half an inch, each of them being strengthened with three gusset stays, secured with double angle irons. The longitudinal seams in the shell were not laid in line, but disposed so as to break joint. The age of the boiler was about two years. It had not been tested by hydraulic pressure. The boiler had been fitted with a single lever safety-valve, the valve being enclosed in a box bonnetted over, from which the waste steam escaped through a discharge pipe, carried through the wall of the boiler house. It had also been fitted with a glass water guage—a feed-check and back-pressure valve combined, fixed to the front end plate, a little below water level—a blow out or mud tap, and a steam pressure-guage, of the dial class; but the boiler had no tap for fixing an indicator, so as to check the accuracy of the guage, and ascertain the actual working pressure with the steam up. The boiler was rent into so many fragments by the explosion that it was completely destroyed, while considerable damage was also done to the surrounding property. Both the furnace tubes were torn away from the end plates, as well as separated into two pieces, dividing at one of the transverse seams at the middle of their length. Three of these lengths, weighing upwards of a ton each, were blown over a row of cottages, one alighting on the first floor of a dwelling beyond, having broken through the roof in its fall, the other two lengths falling at intermediate distances between these two rows of buildings; while the fourth flew in a direction nearly at right angles with the other, and also fell upon a cottage carrying in the roof. The safety-valve weight, which was a ball of about eight inches diameter, was shot upwards, and, on its fall, broke through a third cottage. The shell of the boiler had been torn up into so many pieces that it was difficult to trace the course of the rents, and to determine where they first commenced; but it may be remarked that one of them ran through the manhole, which was not strengthened as it should have been by a substantial mouth-piece. There fragments of the shell had not flown so far as the flue-tubes had done, but many of them lay scattered near the original seat of the boiler, while some were buried under the ruins. The end wall of the mill was blown down, and the various floors laid open, while the engine was completely buried in the *debris*. The chimney was gashed by a large rent, running up it for half its height, and stood tottering over the old seat of the boiler, so that approach was dangerous; while the ground surrounding was covered with bricks, and the ruins of the injured buildings; the windows in every direction, as well as many of the roofs being riddled. But it is difficult to convey an adequate idea of the ruin that had been produced. With regard to the explosion having arisen from shortness of water, it was given in evidence at the inquest that the guage-glass was blown through, and plenty of water observed shortly before the explosion happened; the correctness of which was borne out by subsequent examination, since the flues were found to be coated with incrustation which overheating, had it occurred, would have disturbed; while, in addition, the furnace-crowns could not have retained their shape as they did, had the water been low. As to the explosion being due to excessive pressure consequent upon the defect of the safety-valve, it is true that the spindle of the valve was bent, but it is a matter of opinion whether this did not become so subsequently to the explosion, and was its consequence rather than its cause. At the time of making my own examination, which was done immediately on the explosion being reported, there was no opportunity of seeing the safety-valve, since it was in the hands of the jury who were then engaged upon the inquest—but I am informed, on good authority, that the injury was such as could not have occurred to the valve in regular work, while it was known to have been previously in good order. But, apart from the condition of the safety-valve, there are other considerations affecting the view that the pressure exceeded 60lb. per square inch, and neither that nor twice the amount would have rent the shell had the material and the workmanship been good; while from the fact that the flue-tubes were not collapsed, and the shell was rent into fragments—although the latter should have resisted twice the strain of the former—it is clear that the explosion did not result from simple over pressure. It cannot be doubted that the plates were of very bad quality, one of them in the shell, situated at the top of the external flue, had fractured through the solid when the boiler was at work a few months since, while it is reported that one of the scientific witnesses who gave evidence at the inquest stated—that merely with the blow of a brick he had broken off a piece of plate about 15 or 16 square inches in area, and seven-sixteenths in thickness. Also another engineer who had an opportunity of fully examining the plates after the inquest was closed, has informed me that he found them to be very inferior, while a specimen kindly forwarded to me, at my request, by the owners of the boiler, shows a short and crystalline fracture, is little better than cast-iron, and quite unfit for use. The cast-iron nature of the plates rendered them less adapted to withstand the tensile strain of the shell than the compressive one of the furnace tubes, which therefore accounts for the shell having been broken up into pieces, while the furnace tubes were uninjured, except by the effects of the explosion itself.

At the ordinary monthly meeting of this Association, held August 25th, the chief engineer presented his monthly report, of which the following is an abstract:—

"During the past month there have been examined 313 engines and 401 boilers. Of the latter, 6 have been examined specially, 9 internally, 45 thoroughly, and 341 externally, in addition to which 2 of these boilers have been tested by hydraulic pressure. The following defects have been found in the boilers examined:—Fracture, 5 (1 dangerous); corrosion, 14; safety valves out of order, 7; water gauges ditto, 9 (1 dangerous); pressure gauges ditto, 15; feed apparatus ditto, 2; blow-out apparatus ditto, 27; fusible plugs ditto, 1; furnaces out of shape, 4 (1 dangerous); over pressure, 3; deficiency of water 1 (dangerous). Total, 88 (4 dangerous). Boilers without glass water gauges, 3; without blow-out apparatus, 16; without back pressure valves, 25.

Nine explosions have occurred during the past month, from which five persons have been killed and three others injured. Not one of the boilers in question was under the inspection of this Association. No. 25 explosion occurred to a boiler not under the inspection of this Association, working at a dye-works. But little damage was done to the surrounding property, and the boiler only slightly moved from its seat. The boiler was one of a series of four, ranged side by side, and connected together, all of them being set upon mid-feathers. It was of the internally-fired class, the length of the shell being 28ft., and the diameter, 8ft., the thickness of the plates three-eights of an inch, and the blowing-off pressure, 40lb. The cause of the explosion was the dilapidated condition of the boiler; it had repeatedly been found to leak at the back end, both at the last plate at the bottom, as well as at the flat end one, and had, in consequence, been temporarily repaired, from time to time, with bolted patches. At the time of the explosion there were three of these patches on the boiler, within 12in. of one another. The surrounding plate at length became so eaten away by continual leakage, that it was reduced in places to one-eighth of an inch in thickness, and in others to that of a sheet of brown paper, from which rupture ensued underneath the boiler, at the back end, immediately over the mid-feather.

Mode of Setting an Internally-Fired Boiler of 7ft. Diameter.

"The boiler to be carried on two continuous side walls, spaced 4ft. apart in the clear between them. The top course of these walls on which the boiler rests to consist of fire-brick blocks, which can be obtained of any desired pattern, and should, in the present instance, be of the following dimensions:—Height on the vertical space, 12in.; width on the base, 12in.; width of bearing surface on which the boiler beds, 5in. The angle of this surface, in order to fit the circle of the boiler, should be 38 deg. above the horizontal: this will be best obtained by striking it out full size in accordance with the foregoing dimensions, which can readily be done by any competent bricksetter. The back of the blocks should slope down to a thickness of 4½in., so as to form an abutment against the brickwork at the bottom of the side flues, to prevent the weight of the boiler thrusting the blocks apart. The top of the side flues to be on a level with the furnace crowns, and the bottom on a level with the underside of the boiler. Their width at the top to be 6in., thus making a distance of 8ft. in the clear between the face of the side flues, which should not follow the sweep of the boiler, as is frequently the case, but should run vertically from top to bottom, in order to form a pocket for deposit to lie in without covering any of the heating surface of the boiler, and at the same time to leave room for a man to pass along and examine the plates. The flue beneath the boiler will be formed by the side walls already referred to, spaced 4ft. apart; the height may be about 2ft. The course of the flame immediately after leaving the furnace tubes, to pass under the bottom of the boiler; to split at the front end and return to the chimney through the two side flues. Generally two dampers are introduced, one to each side flue. It is important in boilers with two plain internal tubes, that the course of the flame should pass under the bottom before entering the side flues, in order to promote circulation of the water, and to prevent straining the boiler at the transverse seams of rivets on its under side, and causing what is familiarly known as 'seam rending.' It is not equally necessary, though still advisable, to pass the flames under the bottom before entering the side flues of those boilers which are fitted with tubes or pockets for quickening the circulation of the water. In cases where the angle iron at the front end plate is external, the face of the brickwork should be set back some inches, so that the angle iron may be exposed to view, or leakage may take place without detection. The front cross wall underneath the boiler need not be more than 4½in. thick; otherwise it is frequently found to harbour corrosion. This wall should be recessed so as to leave the blow-out pipe entirely free, in order that it may be accessible to examination, not liable to be strained by settlement of the boiler, nor corrosion of the plates accelerated by contact with the brickwork should leakage occur.

"Mode of Setting Internally-Fired Boilers of Six Feet and Five Feet Diameter.

"For a boiler 6ft. in diameter, the side walls should be spaced 3ft. apart in the clear. The fire-brick blocks should be 12½in. high on the vertical face, 12in. wide on the base, and 4in. upon the bearing surface upon which the boiler beds, the angle of this surface above the horizontal being 33 deg., the other dimensions of these blocks remaining as before. The side flues to be carried down 3in. below the level of the bottom of the boiler, and at the top to be on a level with the furnace crowns, this latter, as well as the remaining particulars being the same as those for the boiler of 7ft. diameter. For a boiler 5ft. in diameter, the side walls should be 2ft. 6in. apart in the clear, the fire-brick blocks 14½in. high on the vertical face, 12in. wide at the base, and 3in. wide upon the bearing surface upon which the boiler beds, the angle of this surface above the horizontal being 33 deg. The other dimensions of these blocks remain unaltered from those given above. The side flues to be carried down 6in. below the level of the bottom of the boiler, and at the top to be on a level with the furnace crowns, the remaining particulars being the same as those for the boiler of 7ft. diameter. For boilers of still smaller diameter if a mid-feather be unavoidable, it should be faced with fire-brick blocks for the boiler to rest on, and the blocks bevelled off to a narrow bearing surface, since one of the causes of injury from mid-feather walls is their width. For a boiler of 4ft. diameter, the width upon the top edge need not exceed 3in. The flues under all circumstances must be sufficiently large to admit of a man's passing right through them for the purpose of examination."

Explosion at Southampton.—A boiler explosion took place at some saw mills in Southampton on the 27th ult. The boiler and engine-house were blown to pieces, and portions of the building were scattered over the neighbourhood. Owing to the explosion taking place in the morning, before the workmen were assembled, no personal injuries occurred.

Boiler Explosion at St. Helen's.—On the 13th ult. a boiler explosion, attended by personal injuries, occurred on the premises of Doulton Brothers, potters, St. Helen's. At a few minutes before eight o'clock in the evening the engine was at work, grinding clay, and suddenly, without the slightest warning, one of three boilers, that are used on the premises, burst with a terrific explosion. The shock was felt in distant parts of the town. The boiler was about 30ft. long and 6ft. diameter. It was riven into several pieces, and one of them, the largest, was carried into the air, passing over the pottery wall.

Explosion near Ipswich.—On the 20th ult., the boiler of a steam thrashing machine, which had been at work all day at a farm in the village of Charsfield, about ten miles from Ipswich, exploded. Two men and a boy were killed, the corn which was being thrashed became ignited, and the produce of 18 acres was consumed.

GAS SUPPLY.

Metropolis.—A parliamentary return has just been issued, showing the actual state and condition of each company, and the dividends for the year 1862. It appears that the following dividends were paid:—The Chartered paid dividends at the rate of 9 and 10 per cent., including back dividends at 1 per cent. per annum for the half-year to Christmas, 1856; the City of London dividends at 9 and 4 per cent., with a balance of £658; the Commercial £30,513, on a capital stock of £322,195 (less sums remaining outstanding). The capital account is said to "include calls in course of payment," but the rate of dividend is not stated. The Equitable paid dividends at the rate of 11, 14½, 14, and 10 per cent. (less sums remaining outstanding), with a balance of £396; the Great Central dividends at the rate of 6 and 8 per cent. (less sums remaining outstanding), with a balance of £18,445; the Imperial at the rate of 10 per cent., with a balance of £58,500; the Independent at the rate of 10 per cent., with one year's back dividend (£1500), and a balance of £3548. The London paid £36,827, on £548,843 (less sums remaining outstanding), but the rate is not stated. The Phœnix was 10 per cent., with £8190 dividend arrears for 1856, with a balance of £930. The Ratcliffe dividend was £8 15s. per cent., without a balance; the South Metropolitan 10 per cent., with a balance of £10,369; the Surrey Consumers, 10 per cent., with a balance of £4047; and the Western, 10 per cent., with £2285 "towards back dividends of less than 10 per cent."

The Worcester Gas Company have announced a dividend of 10 per cent. per annum for the last half year.

THE DEVONPORT GAS AND COKE COMPANY, who lately reduced their charge to 4s., have declared a dividend of 9 per cent. on original shares and 5 per cent. on others for the past year.

THE PENZANCE GAS COMPANY have reduced their price from 6s. to 4s. 6d.

THE ROMNEY GAS COMPANY have reduced the price of gas from 7s. 6d. to 6s. per 1000 cubic feet.

THE TAUNTON GAS COMPANY announce a reduction in the charge for gas from 5s. 6d. to 4s. 6d. per 1000 feet.

THE YORK UNITED GAS LIGHT COMPANY have for the past half year declared their usual dividend of 10 per cent.; being 5s. per share on the old shares, and 3s. on the new shares.

THE BANBURY GAS COMPANY have declared a dividend of 7½ per cent., for the past year.

ST. NEOT'S GAS COMPANY.—A dividend of 12 per cent. is stated to have been declared.

THE LEWES GAS COMPANY having had their annual meeting, have declared a dividend of 10 per cent. for the past year.

THE HUNTINGDON GAS COMPANY have declared a dividend of 9 per cent. for the past half year.

AT ASHFORD a dividend of 6 per cent. has been declared by the Local Gas Company.

THE BURY ST. EDMUND'S GAS COMPANY have reduced their charge from 6s. 8d. to 6s. 3d. per 1000 feet. Their meter charge being also reduced.

THE BAKEWELL GAS COMPANY have declared a dividend of 10 per cent. for the past year.

THE CARLISLE GAS COMPANY have reduced their price to 3s. 4d. per 1000 feet.

THE HAWICK GAS COMPANY have declared a dividend of 7½ per cent. for the past year.

GAS FROM CANNEL AND FROM COAL.—The following analysis of the comparative value of gas made from coals and cannel is by Dr. Andrew Fife, Professor of Chemistry, King's College, Aberdeen:—A ton of English caking coal yields, on an average, at gas-works, 8000 feet of gas; and though a larger quantity was given with my apparatus, yet we must take 8000 as the quantity on a large scale. The value of the coal is taken as 1. The Wigan cannel yielded 9500 and 11,500; the value of the gas, bulk for bulk, being the same, viz., 1·85 to the former as 1. Now, taking into account the quantity of gas afforded, the value of the coals for yielding light, by the consumption of their gases, is as 2·23 for the one quantity, and ·25 for the other. Taking the average, we state the value of English cannel coal as 2·35, or say 2½ to Newcastle coal as 1. The following analysis of the cannel raised by the Ince Hall Coal and Cannel Company, is by Mr. John Leigh, M.R.C.I., Consulting Chemist to the Manchester Corporation Gas Works:—

Carbonic oxide and aqueous vapour	1·53	
Olefiant gas and divers hydro-carbons	8·50	
Atmospheric air	4·32	
Nitrogen	0·19	
Hydrogen	40·30	
Light carburetted hydrogen	33·83	
Carbonic acid	11·35	
		100·02
Quantity of gas produced	11·673 cubic feet.	
Specific gravity of gas	5·20 „	
Coke produced from 1 ton of cannel, 13 cwt. 13lbs.		

This cannel is used by the chief gasworks of this country, including London, Liverpool, Manchester, and Birmingham; and by the principal foreign gasworks, both on the Continent and in North and South America. The analysis of the same company's gas coal, made by Mr. J. E. Clift, Engineer to the Pagoda Gasworks, Birmingham, gives:—

Carbon, from 100 parts	84·50	
Hydrogen, „	5·14	
Oxygen, „	2·10	
Nitrogen, „	2·20	
Sulphur, „	0·33	
Ash, „	4·12	
		98·39
Loss		1·61
		100·00

Products obtained from one ton of gas coal, being the average results obtained from using 300 tons in making gas:—Gas produced, 10,200 cubic feet; illuminating power—one Argand burner consuming five feet per hour = thirteen spermaceti candles of six to the pound; specific gravity, ·462; atmospheric air being 1·00. Coke produced, 13 cwt. 3 qrs., or 44 imperial bushels; suitable for ironfounders, brassfounders, and maltsters. Ammoniacal liquor produced, 20 gallons; 1 gallon requiring 10 oz. of the sulphuric acid of commerce to saturate it. Tar produced, 10 gallons. Purification of the gas:—1000 cubic feet of gas requires 12¾lbs. of lime for its purification, which shows it to be comparatively very free from sulphur. The other impurities of coal gas are not more abundant than in that made from other coals. A further analysis of the same company's gas coal, made by Professor Thompson, of London, gives:—

Specific gravity	1·270
Coke, per cent.	65·2
Volatile matter, per cent.	34·8
Cubic feet of gas, per ton, gross	11,400
„ „ „ purified	11,200
Impurity per cent. in gas	1·8
Specific gravity of purified gas	406·00
Illuminating matter condensible by bromine, per cent.	4·25
Carbonic oxide in purified gas, per cent.	4·00

Illuminating power of the gas, burnt at 5 feet per hour, equal to 13·8 spermaceti candles, each consuming 120 grains per hour. Heating power of the coal:—1lb. will convert 15¾lbs. of boiling water into steam.

THE GAS AT THE GRAND HOTEL, PARIS, costs annually 130,000 francs (£5,200), which is what the lighting costs for the whole town of Orleans, which is a well-lighted city.

NEW MODE OF LIGHTING.—A novel mode of lighting has been introduced at a Baptist Church, just built at Philadelphia. There is not a gas burner in the audience room. In the panels of the ceiling are circles of ground glass, 2ft. in diameter. Above each of these, in the loft, is an argand burner, and over the burner a powerful reflector. The effect is just about the same as if there were 34 full moons shining in the ceiling. The light is not sharp and intense, but abundant and mellow, and not painful to the eyes.

MINES, METALLURGY, &c.

DISCOVERY OF GOLD IN SCOTLAND.—Up among the Hartfell Hills, near Moffat, and about Dobb's Linn and Meggatt Water, several small "finds" of gold have been made recently; one nugget, weighing about 6 grains, has been publicly exhibited.

SIBERIAN GRAPHITE.—Mr. Alibert has just presented to the Museum of Natural History, at Paris, some valuable specimens of graphite from the rich deposits in the government of Irkoutsk. The specimens are of great size and purity, and some of them are very artisitically wrought, amongst them being a bust of the conqueror of Siberia. The whole collection is mounted, as a trophy, upon a magnificent block of nephryte, weighing some 2 cwts.; this the donor has also obtained from the same district.

COAL.—The quantity of coal received at the port of London during the month of July last, from the various railways having access to the metropolis, has exceeded the quantity for the corresponding month of July 1862, by 16,818 tons 18 cwt. The supply for the month of July 1863 being 126,273 tons, against 109,455 tons 2 cwt. for July, 1862.

APPLIED CHEMISTRY.

PURIFICATION OF COPPER, BY MM. E. MILLON AND A. COMMAILLE.—The copper to be purified we treat with commercial sulphuric acid diluted with half its volume of water. The addition of water moderates the reaction, and regulates remarkably the disengagement of sulphurous acid, a fact not to be neglected in the preparation of the latter gas. It matters little whether the sulphuric acid employed is arsenical; after fifteen or twenty minutes' boiling all the arsenic contained in the acid is precipitated, and we know of no better means of freeing from arsenic an impure sulphuric acid. On continuing the boiling, the copper dissolves in the sulphuric acid, and separates from the arsenic it contains. The sulphate of copper formed contains no trace of any arsenical combination. The whole of the metalloid is recovered in the form of a black powder, described as oxysulphide of copper, and on which sulphuric acid has no action. When the disengagement of sulphurous acid is at an end, boiling water is poured on the residium of the operation, which is then heated, so as to dissolve the sulphate of copper formed; the acid liquid is allowed to remain until the black oxysulphide of copper is deposited; then the liquid is decanted, evaporated to dryness to get rid of the excess of sulphuric acid, and the sulphate of copper recovered by hot water from which it crystallises. Sulphate of copper obtained in this way almost always contains iron, and not unfrequently zinc. Copper is easily separated from the two other metals by an electric current. With the above salt an acid solution is formed, into which the platinum electrodes of a pile is introduced. The current is so regulated that the deposit takes place, not in a pulverulent form, but in that of flexible homogeneous flakes. A large excess of salt of copper must be maintained in the solution. The copper thus precipitated possesses all the characters of absolute purity. Among the experiments employed to detect the presence of iron, the singlar reaction produced by the contact of copper leaves with a solution of cupric salt may be mentioned, containing a large excess of ammonia. The operation is conducted in an air-tight flask, quite filled with an ammoniacal solution of salt of copper. When this solution is not very concentrated the metallic copper rapidly dissolves, and the blue liquid soon loses its colour; if the copper and the cupric solution are quite pure, the metal simply dissolves, and the bisalt changes to protosalt. But should the metal or the solution contain iron, that metal will be precipitated as a yellow powder, very alterable by contact with air. The yellow powder contains but an infinitesimal quantity of iron, and is principally composed of protoxide of copper, zinc is also precipitated. The analysis of this powder gives the following proportions:—

Copper	99·17
Iron	0·50
Zinc	0·33

This elimination of iron and zinc would not be possible did the ammoniacal salt of copper contain oxalic or tartaric acid; but we have proved it with cupric phosphate, nitrate, sulphate, and chloride. It is not easy to explain why so small a quantity of iron induces the precipitation in the state of oxidule of a quantity of copper two hundred times larger. It is an unique influence, and for an instant led us to believe in the existence of copper of an undetermined metal; but the copper accompanying the iron has exactly the properties of ordinary copper. In any case we know no more sensitive process for ascertaining even the least indication of iron in copper and its combinations; we made use of it in testing the copper obtained by the previously described method, and in 25 grammes of purified copper found no trace of iron.

TREATMENT OF POISONING BY CORROSIVE SUBLIMATE.—When a solution of corrosive sublimate is placed upon a bright piece of gold and touched with an iron point, it undergoes decomposition, a thin film of metallic mercury being deposited on the surface of the precious metal. Dr. J. C. Johnstone, of Baltimore, by the practical application of this fact, has succeeded in saving the life of a gentlemen in that city who had swallowed two crucibles of the bichloride of mercury. In less than half an hour afterwards he had given his patient a bolus composed of half a book of gold leaf, having previously sprinkled a drachm of iron reduced by hydrogen between its leaves. This dose was retained but a short time, when it was repeated with the happiest results; the vomiting and distress ceased; and the man recovered rapidly under the ordinary treatment for gastritis. Dr. Johnstone thinks that, if the gold leaf had been rubbed in a mortar with bright iron filings, and the mixture given with water, it would have been more speedily successful than the plan he adopted in his hurry.

AN IMPROVED PROCESS FOR THE PREPARATION OF CHROME YELLOW AND RED, BY J. FRAUZOY.—The author takes one hundred pounds of litharge, places it in a sufficiently large trough, and adds ten pounds of common salt, and enough warm water to make the whole into a thin paste. In the course of twenty-four hours the mixture swells up, and should then be well stirred. If it has become very thick, more water is added, until it reaches its original consistence. This is repeated as often as necessary, until the whole paste is decomposed, and chloride of lead formed, which generally happens in four or five days with the temperature at 68° or 70° F. Twelve pounds of nitric acid are now added; the mixture is again well stirred, and then left at rest for some hours. Fifteen pounds of alum dissolved in sufficient water to make a saturated solution are then added, and the mixture is once more well stirred. The chloride of lead is now changed into sulphate of lead oxide. After some hours the sulphate of lead, without pouring away the mother liquor, is added, stirring continually, to a solution of bichromate of potash. The latter must not be very strong, but should contain a pound of the bichromate in fifteen pounds of water. If a bright yellow shade is desired, the chromate of potash solution is to be added to the sulphate of lead quite cold, and in a small stream, the mixture being incessantly stirred. In this way a beautiful light chrome yellow is obtained. In the first process the solution of bichromate is made use of warm. In preparing an orange colour the author uses carbonate of soda in place of alum. To make chrome red he adds a concentrated solution of bichromate of potash directly to the chloride of lead without forming either sulphate or carbonate. The mixture is well stirred, and in twenty-four hours a most beautiful chrome red is obtained. Lastly, the colours are washed, the washings decanted, the last water is removed by pressure, and the colour is made up and dried.

PREPARATION OF CHLORIDE OF LIME, BY C. SCHRADER.—The author gives the following as the conditions under which a good chloride is obtained, which will keep its strength for a long time:—1. The lime employed must be free from iron and alumina. The hydrate may contain from 6 to 12 per cent. of moisture without any injury to the result. 2. The chlorine must be passed slowly to the hydrate of lime. If this precaution is neglected, the absorption may be so rapid as to produce an elevation of temperature, and cause the formation of some chlorate of lime. 3. When the hydrate is supersaturated with chlorine, the chloride obtained quickly decomposes, consequently it is necessary to employ the hydrate and hydrochloric acid in proper proportions determined by practice. These proportions will necessarily vary with the strength of the hydrochloric acid and the purity of the manganese. 4. In proportion to the absorption of chlorine the affinity of the hydrate of lime for chlorine diminishes; so at the close of the operation the apparatus must contain free chlorine in a gaseous state, or the finished chloride will have an excess of hydrate of lime. 5. By attending to these points a product may be obtained, which will contain from 33 to 35 per cent. of bleaching chlorine, and which will lose only 3 or 4 per cent. of its strength in the course of a year.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated July 24th, 1863.

1850 J. Kirkland—Working hydraulic presses.
1851 W. L. Barnes—Stopping railway trains or other locomotive carriages.
1852 A. English—Protecting horses and other cattle during their transit by rail and on board ship.
1853 T. Sturgeon—Chains.
1854 B. Bainbaum—Gaiters and leggings.

Dated July 25th, 1863.

1855 T. C. Bull & T. Morgan—Collecting fruit from trees without injury.
1856 G. H., J. M. J., & J. James—Covers for purses, wallets, and pocket books.
1857 P. E. Gay—Boring apparatuses.
1858 J. Boyd—Forming imitation selvages or longitudinal cords in weaving.
1859 F. Tolhausen—Gun barrels.
1860 C. Crockford—Treatment and utilization of certain of the waste products from the manufacture of alkali and bleaching powder, and also from certain smelting operations.

Dated July 27th, 1863.

1861 J. W. Welch—Sizing and finishing fabrics.
1862 W. Tranter—Breech-loading and other revolving fire-arms.
1863 F. & L. Ford—Imitation of different kinds of marbles or similar ornamental materials.
1864 T. Thorne—Disengaging ships' boats.
1865 G. Haseltine—Coal oil lamps.
1866 R. A. Brooman—Sleepers or supports for the rails of railways.
1867 J. Pain—Umbrellas and parasols.
1868 J. Whittaker—Obtaining motive power.

Dated July 28th, 1863.

1869 R. Dawson—Extinguishing fires.
1870 M. Cockerell—Locks and latches.
1871 A. Hector—Facilitating the catching of fish.
1872 A. A. A. B. de Rostaing—Manufacturing iron and steel with cast iron taken in the divided state.
1873 D. Taylor—Ventilating bay, corn, and other ricks.
1874 J. Jewell—Setting boilers.
1875 W. T. Smith—Securing the cords of blinds and other rollers.

Dated July 29th, 1863.

1876 J. Sainty—Feeding troughs for sheep and other cattle.
1877 P. H. Girardin—Lamps.
1878 N. Thompson—Stopping the hung holes of casks and similar vessels.
1879 G. Rickarby & T. A. Barrett—Window frames and sashes.
1880 H. A. Bonneville — Self-acting flushing apparatus.
1881 W. E. Newton—Cartridges.
1882 E. Sturge—Coating metallic surfaces.

Dated July 30th, 1863.

1883 G. Inskeep—Grinding bones, grain, logwood, and such like substances.
1884 J. W. Branford—Longitudinal and transverse hoe.
1885 J. Boeddinghaus — Printed or particoloured yarns.
1886 J. T. Stephens & C. Hoare—Yarns, threads, laid twine, and other cordage.
1887 J. B. Howell—Ordnance, fire-arms, and projectiles.
1888 W. & S. Firth—Working coal and other mines, and loading waggons and other vehicles.
1889 G. Smith—Railway carriages and waggons.
1890 R. Hoe & H. J. Cole—Packing cases.
1891 T. Apps—Four-wheeled vebicles.

Dated July 31st, 1863.

1892 W. & J. Graham—Looms.
1893 G. Sigl—Force pumps.
1894 J. C. Haddau—Fire-arms, and artillery and projectiles for the same.
1895 J. P. Culverwell—Railway lamps.
1896 J. B. Andreux—Application of steam to toy boats.
1897 B. Johnson—Pianofortes.
1898 J. F. Dickson—Boots and shoes.
1899 A. R. Arrott — Bleaching certain vegetable fibres.
1900 R. Stewort—Operating the cut-off valves of steam engines.

Dated August 1st, 1863.

1901 W. Cotton—Looped fabrics.
1902 R. A. Brooman—Dyeing mixed animal and vegetable fibres.
1903 R. A. Brooman—Warming pan.
1904 G. Taylor—Shaping boiler and other plates.
1905 J. Hoeller—Treating Codilla fibre and tow, to render them available as a substitute for cotton.
1906 J. Kirk—Looms.
1907 T. Bradshaw—Giving motion to dobby horses, flying and swinging boats, or similar apparatus used for public amusement.
1908 R. E. Bibby—Fireproof cement.
1909 E. Sutton—Fastenings for cigar cases, portemonnaies, and bags.
1910 T. Fellowes & H. Hemfrey—Elevating straw and other agricultural produce.
1911 J. E. Vanner—Umbrellas and parasols.

Dated August 3rd, 1863.

1912 E. A. Cowper—Self-acting mules for spinning.
1913 J. W. P. Field—Sheaths or cases for staves or other similar weapons.
1914 B. W. Gerland—Size, glue, and phosphates.
1915 J. I. P. Bonnet & J. Pfister—Lamps.
1916 H. Woods—Regulating the temperature during the process of fermentation.
1917 J. Munro—Producing optical illusions.

Dated August 4th, 1863.

1918 C. Gouty—Folling, thickening, felting, and cleansing cloths.
1919 J. Abrahams—Brakes for railway and other carriages.
1920 T. H. Baylis—Hawse pipes, mooring pipes, and deck chain pipes.
1921 G. Stevens—Effecting a regular supply of air or aeriform fluids for various purposes.
1922 S. Bury & J. Price—Valves for steam engines.
1923 J. H. Walsh—Breech loading fire-arms, and extracting cartridge cases therefrom.
1924 E. A. Cotelle—Manufacturing gas alcohol by means of diluted acids acting indefinitely without reconcentration.
1925 W. E. Newton—Moulding and casting hollow projectiles.
1926 E. Pace—Cutting splints for matches, and collecting the same.
1927 T. Pickersgill — Feeding wool, cotton, and other fibrous materials into machines for preparing the same for spinning.

Dated August 5th, 1863.

1928 E. A. Cowper — Furnaces for heating air, steam, and other elastic fluids.
1929 G. Clark—Construction and protection of ships, vessels, and floating batteries.
1930 G. Wilkins—Railway signalling.
1931 W. Storer & J. Hancock — Electro motive engines.
1932 C. Garton & T. Hill—Evaporating and cooling.
1933 W. Hodson—Propelling carriages and vessels.
1934 A. V. Newton—Stereoscopic plates.

Dated August 6th, 1863.

1935 G. Gowland—Mariners' compasses.
1936 C. Lowe—Dyeing and printing.
1937 J. E. Dowson—Metallic structures.
1938 J. G. Fenede—Regulating the speed of steam and hydraulic engines.
1939 W. P. Hodgson & J. V. Woodfield—Rivets.
1940 J. Tenwick—Self-acting valves and traps for sewers.
1941 J. Young—Preservation of animal matter.
1942 W. Clark—Ovens.
1943 W. Clark—Tap or stop cock apparatus.
1944 G. E. Charageat—Frames for umbrellas and parasols.
1945 E. E. Guelle—Ink stands.
1946 J. Kirkham—Generating heat for smelting and other purposes.
1947 T. Simmelkiar & J. I. Spicer—Painting the bottoms of ships or vessels.

Dated August 7th, 1863.

1948 C. or K. Liddle—Cooking an egg.
1949 W. Jones—Steam boilers.
1950 F. G. Mulholland—Pipe castings for gas, water, or sanitary and other general purposes.
1951 A. V. Newton—Shuttles.
1952 J. W. Slater—Production of yellow and orange colouring matters.
1953 J. H. Johnson—Preventing sea sickness.
1954 R. A. Brooman—Coke ovens.
1955 E. Watson—Apparatus whereby screw propellers may be made to steer as well as propel.
1956 J. Platt—Supplying steam boilers with water.
1957 T. W. Gillod—Chess boards and chessmen.
1958 E. Morewood—Coating metals.
1959 J. Thompson & E. G. & F. A. Fitton—Carding engines.

Dated August 8th, 1863.

1960 N. Jarvil & W. Miller—Oakum.
1961 W. B. Robins—Extinguishing fires.
1962 J., J., A., & W. Thornton—Producing looped fabrics.
1963 A. P. Price —Application of india rubber and gutta percha to the manufacture of brushes and mats.
1964 H. R. Brown—Apparatus for the regulated delivery of cards, tickets, labels, bills, and sheets or pieces of cardboard, paper, metal or other material for advertising or other purposes.
1965 M. Smith — Obtaining farinaceous material from potatoes.
1966 J. W. Armstrong—Fastenings for the rails of railways.

Dated August 11th, 1863.

1967 J. A. Fullerton—Fastening hoops for packing bales.
1968 P. M. del Rio—Obtaining motive power.
1969 B. Heyne—Apparatus to facilitate sketching and drawing landscapes, buildings, machinery and other objects in correct perspective.
1970 R. Dickson—Lithographic printing presses.
1971 R. J. Cunnack—Cartridges for blasting and projectile purposes.
1972 A. V. Newton—Blue and violet colouring matter.

Dated August 10th, 1863.

1973 J. Robson—Money tills.
1974 E. S. Simon—Fastening for leggings.
1975 E. Myers & H. Forbes—Rotary pump.
1976 W. Knowles & R. Halliwell—Preparing, spinning, and doubling cotton.
1977 D. W. Barker—Apparatus for actuating rotary shuttle boxes.
1978 J. T. King—Lighting railway carriages, steam boats, and other moveable vehicles and vessels.
1979 W. B. Haigh—Equilibrium saw frame.
1980 A. V. Newton—Hardening cast iron.
1981 J. G. Willans—Iron.
1982 W. Clark—Road sweeping machines.
1983 J. Wheeler—Perfuming gloves.
1984 W. Gray—Reaping machines.
1985 Sir J. S. Lillie—Revolving battery.

Dated August 12th, 1863.

1986 G. Graham—Baths or boilers used in dyeing.
1987 R. Musbet—Cast steel.
1988 J. Cornforth & A. Andrews—Nails.
1989 L. R. Bodmer—Dressing, finishing, and imparting a lustre to yarn and thread made of silk, cotton, and other fibrous substances.
1990 R. Canham—Moulds for casting.
1991 J. Templeman—Artificial fuel.
1992 R. S. Newall—Drying chemical compounds and other substances.
1993 R. Wappenstein—Prevention of forgery.
1994 W. Hudson, C. Catlow, & J. Dodgeon—Looms for weaving.
1995 R. S. Newall—Serving ropes for ships' rigging and other purposes.
1996 W. Clark—Lamp for burning coal oil and other similar hydro-carbons without the aid of a draught chimney.

Dated August 13th, 1863.

1997 J. Ellis—Scouring, cleaning, and polishing wheat, rice, malt, grain, and other seeds.
1998 C. C. Dennett—Fire-proof buildings.
1999 H. Winchcomb—Street pillar letter boxes and bags for the reception of post letters.
2000 J. Edmunds—Gun and pistol furniture.
2001 T. Ashwin—Dress fastening.
2002 C. Tessier—Safely closing doors, windows, and other apertures.
2003 J. Henderson—Preparing yarns for printing.
2004 M. A. F. Mennons—Numbering machines.
2005 E. Deane—Artillery and fire-arms, and projectiles for the same.
2006 H. Brown—Burners for lamps for burning oils or fluids.

Dated August 14th, 1863.

2007 A. E. Brae — Conducting electric currents through railway trains and actuating signals or alarums therein.
2008 C. Schiele—Fans, pumps, and for propelling air, fluids, or other substances by centrifugal force.
2009 S. R. Wilmot—Hand trucks.
2010 R. B. Greenwood—Preventing accidents upon railways.
2011 E. Taylor—Churning.
2012 E. B. Wilson—Blast furnaces.
2013 F. J. Jones—Locks or fastenings.
2014 M. H. Lishman—Punching and marking plates in which holes are to be punched.
2015 M. Siegrist—Railway breaks actuated by the pressure of the atmosphere.
2016 N. S. Russell—Working great guns.
2017 J. Wain—Doubling threads of cotton and other fibrous materials.
2018 W. Aabury—Axle and axle boxes.

Dated August 15th, 1863.

2105 J. Taylor—Soap.
2019 J. W. Hoffmann—Producing optical illusions for stage effect in theatres or exhibitions.
2020 P. F. L. B. Hirn—Waterproof preparation to make fabrics, thread, textile matters and others impenetrable against water.
2021 G. Tates—Indicating the number of tubs or other measurea drawn from mines.
2022 G. Davies—Furnaces for heating, flattening, and annealing glass.
2023 E. Scott—Regulating the speed of engines.
2024 R. Parker—Preparing, spinning, and doubling cotton.
2025 R. Smith & J. Booth—Paper hangings.
2026 E. Lord—Preparing, spinning, and doubling cotton.
2027 F. Flavell—Shakers for thrashing machines.
2028 J. E. F. Ludeke—Keeping cameras or other apparatus steady when suspended to balloons.
2029 T. Brooks—Production of charcoal and other products from refuse tan and other woody substances.
2030 J. Grantham—Salt.
2031 A. V. Newton—Printing.
2032 R. Lightbown—Looms.
2033 E. H. Bentall—Thrashing corn and other grain or seeds.
2034 G. T. Bousfield—Cement.
2035 A. W. Parker—Soap.

Dated August 17th, 1863.

2036 J. Smith—Finishing woven fabrics.
2037 A. M. Dearn — Centrifugal disc mashing machine.
2038 H. A. Bonneville—Engraving.
2039 H. A. Bonneville—Spinning wool.
2040 W. Longbottom—Lubricator.
2041 R. Baillie—Reefing or furling the sails of vessels.
2042 T. Loftus—Apparatus for attaching to steam boilers and flues for the consumption of smoke.
2043 J. S. Crosland—Lubricator.

Dated August 18th, 1863.

2044 J. Broadley—Weaving.
2045 J. Arthur — Prevention, cure, and relief of hernia of every description.
2046 J. Briggs—Covering crinoline steel.
2047 J. Brennaud—Fire bars.
2048 H. Robinson—Lime kilns.
2049 T. Dobb—Chimney tops.
2050 A. Cruickshank—Food for cattle and all other domestic animals, poultry, and game.
2051 J. Yates—Securing armour plates, blocks, or bars.
2052 R. A. Brooman—Hats, caps, and bonnets.
2053 R. A. Brooman—Treating molasses, syrups, saccharine juices, and other products.
2054 J. B. V. Faure—Pen and ink holders.
2055 C. H. McCormick—Reaping machines.
2056 C. G. Wilson—Pressing cotton and crushing and pressing other substances.

Dated August 19, 1863.

2057 W. Jackson—Sewing machines.
2058 C. Sonnhammer—Fan.
2059 T. Howord—Spinning cotton, flax, wool, silk, and other fibrous substances.
2060 F. Scott—Floating docks for lifting ships and other bodies.
2061 G. T. Bousfield—Feeding weft in hair cloth looms.
2062 S. Sanderson—Fastening for leggings, stays, or other articles.
2063 G. Bonelli & H. Cook—Producing optical illusions of moving animals and bodies.
2064 R. H. Jackson—Sawing wood and other fibrous substances.

Dated August 20th, 1863.

2091 H. Batt—Roughing horses by the application of a clog instead of taking off the shoe.
2065 G. Spencer—Preservation of wood, stone, and metallic surfaces.
2066 W. & J. Galloway—Steam boilers and steam water gauges.
2067 S. Hallsworth & T. Platt—Colouring matters.
2068 W. Hamilton—Spring mattresses.
2069 J. Fleming—Preserving the colours of dyed fabrics.
2070 J. Platt & W. Richardson—Cleaning cotton and wool.
2071 J. Platt & W. Richardson—Winding narrow laps of wool.
2072 W. E. Newton—Cartridges.
2073 C. D. Hammond—Treatment of certain bodi[ly] ailments.

Dated August 21st, 1863.

2074 J. F. Hill—Improved ventilating gas lamp gasalier.
2075 J. Eccleston—Economising or regulating wa[ter] power used for blowing organs and harmoniu[ms].
2076 T. F. Cashin—Means of communication [be]tween the passengers, guard, and driver of a ra[il]way train in motion.
2077 R. Thompson—Machinery for planing curve[d], curvilinear, irregular, and other forms in iro[n], steel, and other metals.
2078 R. A. Brooman—Expressing and filtering o[il] from seeds, and liquids from other substances co[n]taining the same.
2079 W. Evans—Artificial fuel.
2080 R. Griffiths—Construction of retorts or oven[s] for extracting oil from cannel coal or other bitu[]minous substances.
2081 E. Pope—Improvements in breech-loading fire arms.
2082 J. B. C. Lange—Apparatus for indicating the speed or distance travelled by vehicles and carriages.

Dated August 22nd, 1863.

2083 T. Pegiam—Plate holder for the photographic camera, adapted to carry different sized plates, each plate being on the same plane and in the same focus.
2084 R. A. Brooman—Closing powder canisters and other vessels.
2085 A. Watson—Inserting pictures in and withdrawing them from photographic albums.
2086 R. A. Brooman—Metallic alloy.
2087 L. E. C. Martin—Apparatus for heating and purifying water.
2088 S. Moure—Apparatus for electro-plating and for medical purposes.
2089 H. J. Simlick—Fusees or matches to light cigars or pipes.
2090 W. Benson & P. W. Greenwood—Preparing and spinning wool and other similar fibres.

Dated August 24th, 1863.

2092 A. Jobson—Drawing or discharging coke ovens and loading coke wagons.
2093 L. Guillemot — Force matrice or perpetuel mouvement.
2094 C. S. Grassot—Machinery used for cleaning cotton from its seeds.
2095 A. Capello— Improved method of glazing morocco leather.
2096 F. R. Stack—Military bridges, piers, landing stages, and escalading apparatus.
2097 H. F. McKillop—Improvements in cleaning ships' bottoms.
2098 R. A. Brooman—Improvements in air and gas engines.

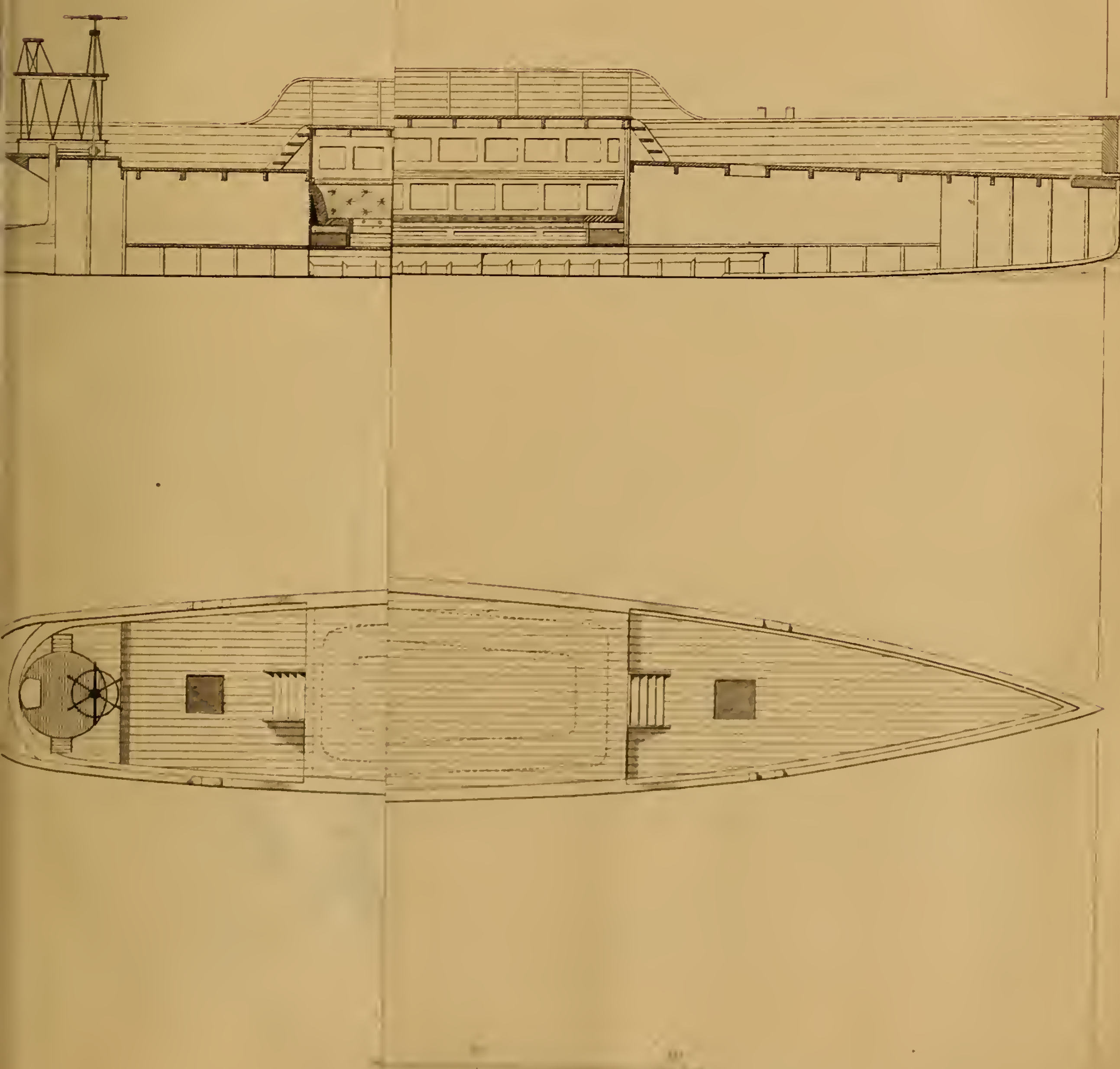
Dated August 25th, 1863.

2099 A. Hett & F. W. Basset—Preserving meat and other substances used for food.
2100 G. E. Lewis, H. Walker, & J. B. Wayne—Fire-arms.
2101 W. E. Gedge—Candles.
2102 J. W. Friend—Gas meters.
2103 J. Thomas & W. F. Marshall—Spinning.
2104 T. Hopkins—Carriage door handles.
2106 J. L. Kessler—Evaporating and distilling.

Dated August 26th, 1863.

2107 S. Fattorini—Division of time.
2108 T. Westhorp—Preparing cut rope strands or yarn for carding into oakum.
2109 R. Johnson & G. Bedson—Pointing wire rods to facilitate their introduction into draw plates.
2110 W. E. Newton—Extracting coal from mines.
2111 J. Platt & W. Richardson—Stoves.
2112 J. Fry—Mashing machinery used in making fermented liquors.
2113 D. Blake—Shaping and punching metallic articles.
2114 J. H. Johnson—Obtaining and applying motive power.

Plate 24



...th. C.F. ...

HYDRAULIC PROPELLER

As fitted to the "Seraing No 2"

CONSTRUCTED BY THE SOCIÉTÉ COCKERILL, SERAING, BELGIUM.

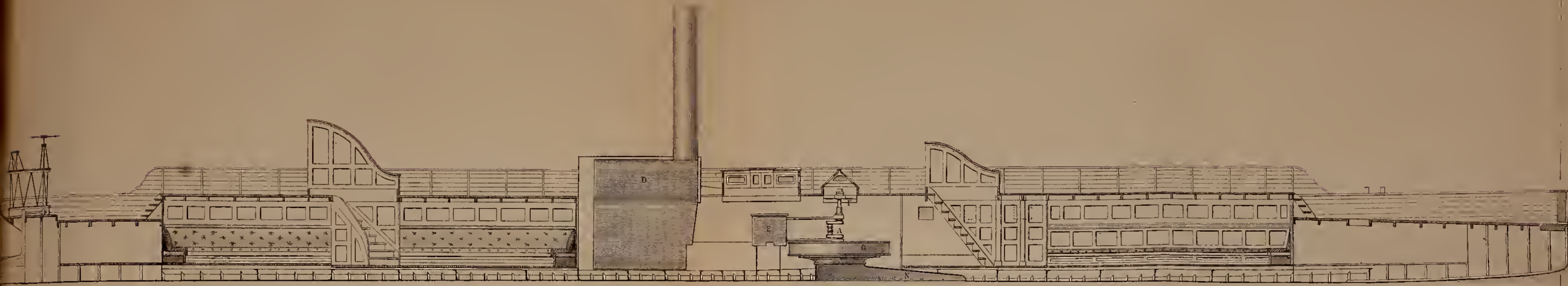


FIG. 1. LONGITUDINAL SECTION.

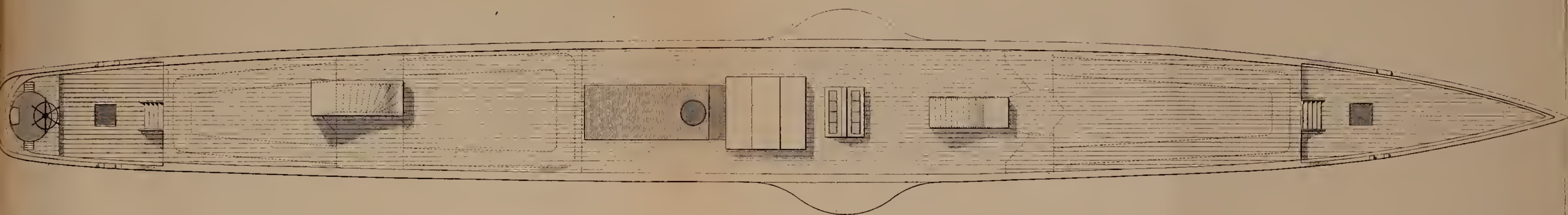


FIG. 2. PLAN OF DECK.

HYDRAULIC PROPELLER.

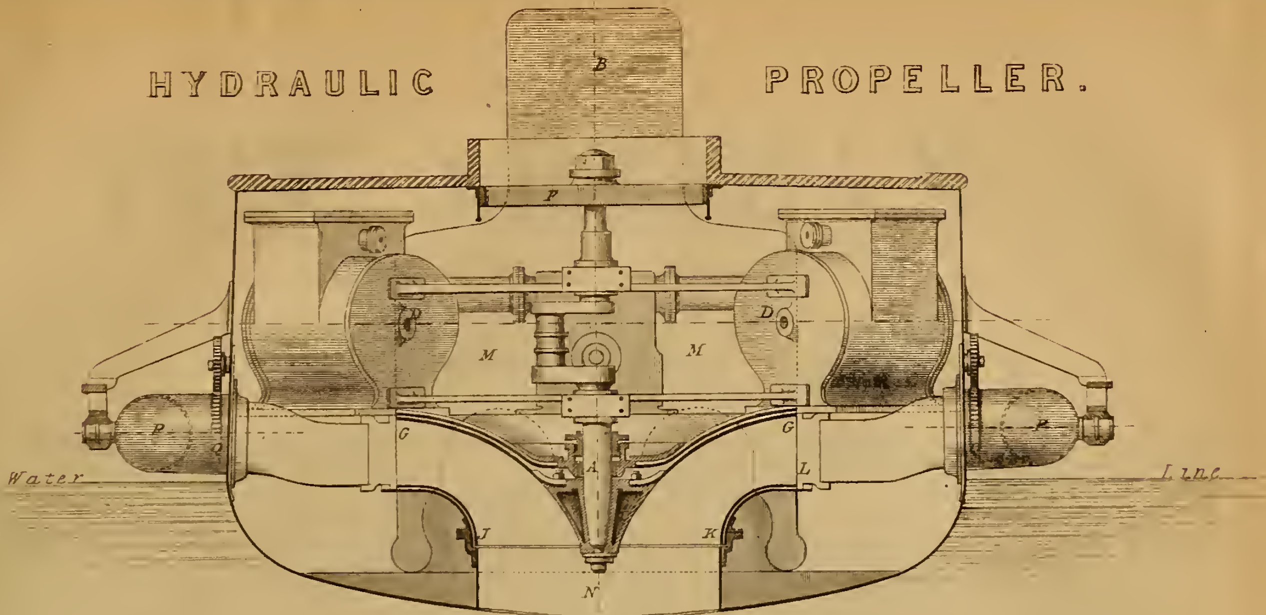


FIG. 1.

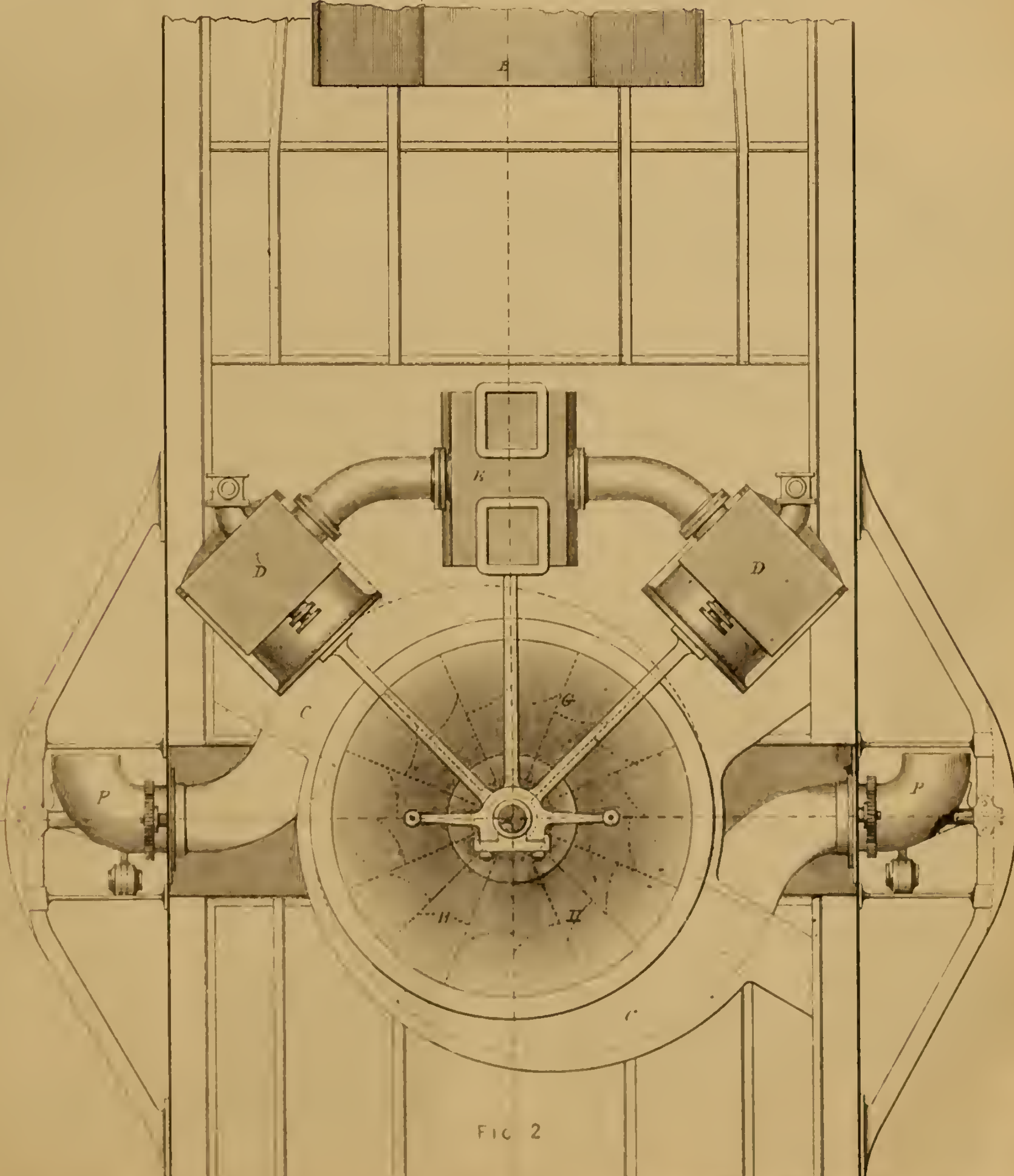


FIG. 2

15 Feet

THE ARTIZAN.

No. 10.—Vol. 1.—Third Series.

OCTOBER 1st, 1863.

WATER - JET PROPELLED SHIPS.

(*Illustrated by Plates* 249 *and* 250.)

Considerable attention has recently been given to the necessity which exists for the employment of some efficient arrangement of submerged propellers. The Admiralty, impressed with the importance of having a means of propelling and manœuvring vessels by a propeller so placed as to be nearly, if not entirely, free from the liability of being shot away or otherwise damaged when in action, have given this subject their serious attention, and, we understand, it has been decided that one of her Majesty's ships is to be propelled by means of water projected through nozzle-pipes, placed one on either side of the vessel. We may add that we believe it is mainly owing to a sense of the importance of this principle, and the intention on the part of the Admiralty to adopt it, that Mr. Ruthven recently obtained from the Privy Council a prolongation of his patent.

Some time since, Messrs. Cockerill, of Seraing, near Liège, built a steamer intended for passenger traffic on the river Meuse, and fitted to her a hydraulic or water-jet propeller, being a modification of Ruthven's patent.

The accompanying plate, 249, shows the general arrangement of the vessel, and Figs. 1 and 2, Plate 250, show respectively a cross-section and plan of the propelling apparatus, which may be described as consisting of three distinct parts; viz., the motor or engine for working the apparatus, the pump, and the propeller tubes and nozzles.

The same letters of reference are used in both plates to denote the like parts of the apparatus. The motor, M, is a horizontal condensing engine, of 40 H.P. nominal; B, the boiler; DD, the cylinders, placed diagonally, and working upon the same crank pin; E, the condenser, air pump, &c. The crank shaft, A, is placed vertically, and is worked direct from the cylinders; the upper portion of the shaft, A, works in the bearing F; and the lower portion forms the driving axis of the centrifugal pump, G, open at the bottom, JK, and its exterior circumference L. A water conduit or chamber, N, with a number of holes in the bottom thereof, forms the channel of communication between the pumps and the external water; C is the spiral channel or passage around the pump case connected with the propeller tubes. The motion of the pump G, when rotated, being transmitted to the water enclosed, a centrifugal force is generated, by means of which the water, driven off from the axis, ascends into the passage surrounding the pump, and is projected through the nozzles PP, which are capable of being turned in a stuffing-box or gland, Q, so that the vessel may be propelled in either direction; or, if the two nozzles are each placed in opposite directions, the vessel may be turned on the centre, and manœuvred by this means similarly to a vessel provided with twin screws. Moreover, this propelling apparatus is of considerable value where canals, narrow rivers, or tortuous channels have to be navigated—and which is the character of the route upon which this vessel plies—as the extreme breadth of the ship is reduced by 25 to 30 per cent.

The nozzles of the tubes are worked from the deck, and the movements of the vessel may thus be governed directly and independently of the working of the engines; and also independently of the rudder, as, though this might become damaged, and even rendered useless, the vessel could be steered as usual by the proper management and working of the movable nozzles of the propeller tubes.

Although, in the case of the *Seraing*, the vessel which we have illustrated—she being a vessel of very light draught—the nozzles are not submerged (being entirely above the water line);—in war vessels, or in vessels of deep draught, the nozzles would be submerged; and, indeed, the whole of the machinery and apparatus would be placed so far below the water line as to be out of reach of shot.

Thus the hydraulic propeller, whilst it requires no greater draught of water than paddle-wheels, has the great advantage over a screw propelled ship of having the propelling tubes submerged and freed from the contingencies to which a screw is liable, or, in the case of war vessels, of being shot away or damaged by the enemy; and, as an additional security, the propeller-tubes might be placed within the body of the vessel, instead of externally.

Although we have briefly referred to some of the advantages peculiar to the hydraulic propeller, it cannot, on the other hand, be urged for it—nor is it, we believe, intended to do so—that in point of economy of fuel there is anything to be gained by its adoption. We look forward, however, with considerable interest to the purposed adoption of the principle by the Admiralty for the propulsion and manœuvring of ships of war, and hope to be able at some future day to give the results obtained from its application.

We may add that the vessel which we have illustrated and referred to has been running regularly between Seraing and Liège since July of last year, making seven double journeys each day. The distance between the two places is about five miles, and the single journey is accomplished in about thirty minutes, inclusive of four stoppages. We purpose giving, upon another occasion, some formulæ relative to, and results obtained from, experiments recently made with this propeller.

A CRITICAL AND HISTORICAL REVIEW OF LOCOMOTIVE ENGINEERING.

By J. J. Birckel.

(*Continued from page* 193.)

As we are unavoidably compelled to defer giving until next month the second of our series of plates of types of locomotives, and accompanying text devoted to that portion of our subject, we will now, in order to make our task as complete as possible, proceed to supply such omissions as may have occurred in the course of our labours from want of sufficient data on points which are yet matter of disagreement among engineers, and to correct one or two statements as to facts about which we had been misinformed.

Prominently among the former items stands the question of the density or of the relative volume of steam, which of late years has received all the attention due to its importance, and of which we have barely made mention in its proper place in our paper on the Boiler, in The Artizan of January last; with this question we are now enabled to deal in a satisfactory manner, through the courtesy of Drs. Rankine and Fairbairn, to whose researches the scientific world are indebted for the better knowledge they now possess of the subject of the density of steam.

Until the comparatively recent period of 1855, it was universally admitted, with scarcely a dissentient voice, that the law of expansion of steam under constant pressure was the same as that of a perfect gas, as defined by Gay-Lussac; namely, that for equal increments of temperature there are equal increments of volume at the rate of $\frac{1}{273}$ of the volume of the gas at the temperature of melting ice, for every degree centigrade; and that, under constant temperature, the changes of volume and pressure were in accordance with Mariotte's (or Boyle's) law, namely, that for a given weight of gas, the product of pressure by volume remains constant for all degrees of expansion. From a combination of these two laws, and with the data furnished by Dumas, respecting the density of steam at the temperature of boiling water, the general formula reproduced below has been constructed, by means of which all the tables of relative volume of steam had hitherto been calculated, viz.:—

$$\mu = 1669 \times 14{\cdot}7\ \frac{459 + T}{671 \times P} \ldots\ldots\ldots\ldots \text{(1)}$$

where μ is the relative volume (or the volume produced by one cubic foot of water) of steam at the temperature T and of pressure P, and 1669 is the volume of steam at the pressure of 14·7lb. being that of the atmosphere.

The correctness of the tables thus computed, assuming the perfect gas theory to be valid, was dependent upon the accuracy of the observations on the correlation of temperature and pressure, and of the formulæ embodying the same; and to ascertain and define this relation, a series of experiments, on a large scale, were undertaken, in 1830, by Arago and Dulong, which were extended to pressures of 24 atmospheres; and such great care was bestowed upon them, that Pambour, in his work on the locomotive engine, says that "*their results are entitled to the highest degree of confidence.*" The original formula, constructed by them to express that relation, reads as follows, in its most convenient shape:—

$$T' = 110{\cdot}7\sqrt[5]{p} - 39{\cdot}8 \ldots\ldots\ldots\ldots \text{(2)}$$

where T' expresses the temperature in degrees centigrade, measured from

the zero of melting ice, and P the pressure in kilogrammes upon the square centimetre. Previous to their labours, however, Tredgold had constructed a formula for temperatures below that of 212°, which till now held the reputation of being more accurate than any other, for pressures not exceeding four atmospheres. It reads as follows:—

$$T^\circ = 85\sqrt[5]{p} - 75 \ldots\ldots (3)$$

where T° is again the temperature in degrees centigrade, and P the pressure in centimetres of mercury; and the more carefully constructed tables were computed from the data furnished by Tredgold's formula for the pressures below four atmospheres, and from those furnished by Arago and Dulong's formula for the pressures above that named.

As early as 1836, however, Pambour showed, by plausible reasoning, and proved by direct experiment, that the expansion of steam in a cylinder does not take place exactly in accordance with Boyle's law, which supposes the gas to maintain its temperature unchanged; but that, at any point of the expansion, the volume, temperature, and pressure are those of steam at its maximum density, or otherwise of saturated steam; and he accordingly constructed an empirical formula to define the relative volume of steam in terms of the pressure only, the results of which, especially for the higher pressures, agree in a remarkable manner with those obtained by later investigations, which must now be held to be the nearest embodiment of truth that may be expected of human skill. His formula reads as follows:—

$$\mu = \frac{10{\cdot}000}{1{\cdot}421 + 0{\cdot}3312\,p} \ldots\ldots (4)$$

where μ again represents the relative volume, and p the pressure in lbs. per square inch. Pambour's suggestions, however, do not appear to have received the amount of consideration which they deserved, and the perfect gas theory remained the basis of all calculations on the phenomenon of expansion of steam, although it is recorded that at a later date other circumstances had strengthened the suspicion that the results of this theory showed too low densities, and consequently too large volumes, at a ratio of error increasing with the increase of pressure, until the labours of Mayer, Joule, and others placed the science of dynamics into a new phase of its history, by proving experimentally that *heat* and *mechanical energy* are mutually convertible, or otherwise; that heat requires for its production, and produces by its disappearance, a certain amount of mechanical work, ascertained by Dr. Joule to be equal to 772 foot-pounds for every British unit of heat.

It is then that Dr. Rankine conceived the idea that the heat which disappears, in the shape of latent heat, during the conversion of water into steam, represents so much mechanical work performed upon the change of molecular arrangement which has taken place; and from this assumption (to us very natural indeed when the law above enunciated is accepted as a truth), coupled with this other law, that the total heat contained in a fluid, its pressure and its volume, are three quantities of which, when two are known, the third is known also, he has constructed his formula expressing the relation between heat and mechanical work, as represented by the changes of volume and pressure during a given change in the quantity of heat contained in a gas, which formula, when applied to the determination of the density of steam, reads as follows:—

$$V = v + \frac{J\,h}{\tau \frac{d\,P}{d\,\tau}} \ldots\ldots (5)$$

where V is the volume of 1 lb. (in weight) of steam, v the volume of 1 lb. of water at the same temperature, J Joule's mechanical equivalent of a unit of heat (*i.e.* 772 foot-pounds), h the latent heat of evaporation in British units, and $\tau\frac{d\,P}{d\,\tau}$ the mechanical equivalent of so much water as fills one cubic foot more in the vaporous than in the liquid state. In order to find by means of this formula the relative volume of steam at various temperatures, it is necessary, therefore, to have the numerical values of h and of the quantity $\tau\frac{d\,P}{d\,\tau}$, the best known values for which are those deduced from the experiments of Regnault, on the specific heat of water, the total heat of steam, and the relation of temperature and pressure; which latter were instituted to correct the formula of Arago and Dulong, slightly deficient for very high temperatures and pressures. When these are introduced into the above formula, it assumes the following shape:—

$$\mu = 62{\cdot}425\left(v + \frac{772\,h}{2{\cdot}306\,P\left(\frac{B}{461{\cdot}2 + T} + \frac{2\,c}{(461{\cdot}2 + T)^2}\right)}\right) (6)$$

where μ stands again for the relative volume; P for pounds pressure per square foot; T for temperature in degrees Fahrenheit; h the latent heat of evaporation at the given temperature which will be found in the table on next page, and B and C are two constants, the values of which are:—

$$\log. B = 3{\cdot}43642, \quad \log. C = 5{\cdot}59873.$$

It would undoubtedly be matter for satisfaction to our readers, were we to detail before them the considerations which have, step by step, led Dr. Rankine to the relation expressed by formula (5), and it would no doubt incline them to receive the results obtained by the same with a greater amount of faith than the mere statement of a fact can command; but as that formula is an absolute embodiment of the laws of thermo-dynamics, such an attempt would necessitate a complete exposition of those laws, an exposition which it would here be impossible to enter upon, owing to the magnitude of the subject, but for the study of which we refer the reader to Dr. Rankine's treatise "On Prime Movers," where it is dealt with in such manner as to enable every earnest student possessed of a moderate amount of mathematical knowledge to become familiar with the same.

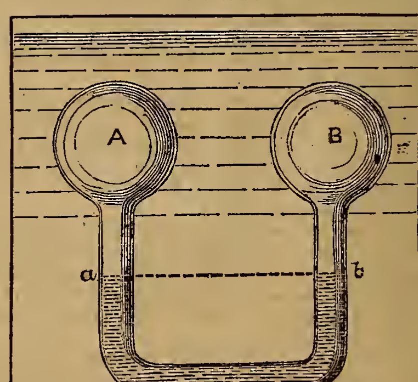
It is very natural in man—and we feel inclined to say also quite competent—to look with an indifferent eye upon the deductions of any new theory not yet verified by direct experiment or by the practice of a majority; and such has been the case in the instance under consideration. Dr. Rankine's first tables were published in 1855, but until now they have not been received by the engineering world generally as representing a nearer embodiment of truth than the old ones; and volumes even have been written by careless observers, and still more careless students, to prove that the dynamical theory of heat, and the deductions drawn therefrom, are utter fallacies.

Meanwhile, however, Dr. Fairbairn, conjointly with Mr. Tate, undertook a series of experiments, the object of which was to measure directly the specific volume of saturated steam; and in order to satisfy the minds of our readers that those experiments were conducted with every possible care, and with such unmixed desire to ascertain the true state of facts as entitle the results arrived at to our entire confidence, we give below a short account of the mode of conducting them, together with a sketch of the apparatus which was used.

The method followed consisted in vaporising a known weight of water in a large glass globe with a stem, of given capacity and devoid of air, and observing the exact temperature at which the whole of the water was just vaporised; then, knowing the weight, volume, and temperature of the steam, its density was easily calculated. The difficulty hitherto had been to ascertain with sufficient accuracy the temperature at that point when the whole of the water was vaporised, and when the steam was still at its maximum temperature of saturation; but in these experiments it has been overcome with great ingenuity by the use of what has been termed a *saturation gauge*, which may be illustrated as follows:—

In the adjoining cut (Fig. 1), suppose A and B to be two globes devoid of air, connected by means of a bent tube containing mercury, and immersed in a liquid bath to ensure uniformity of temperature; let A contain a certain quantity of water, and B double that quantity; and let heat be applied to the liquid bath until the water gradually passes into steam. The elastic force of the steam in each globe will increase with the

FIG. 1.

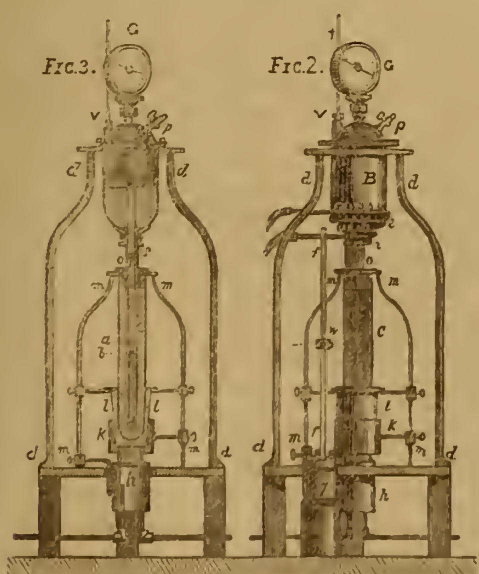


temperature without in the least affecting the uniformity of level of the mercury columns a and b, until the whole of the water in the globe A has been vaporised; but when this has taken place, the pressure in the globe B will increase in the ratio of saturated steam, whilst that in the globe A

increases only in the much smaller ratio of superheated steam, and the mercury column a will rise, whilst b will fall. The instant at which the difference of level begins to take place, is the point at which the whole of the water in A is converted into steam, and the temperature then noted is the maximum temperature of saturation. The density or relative volume of steam may now be easily found as follows:—Let w be the weight of the water vaporised in the globe A; W the weight of the water (at its temperature of maximum density) which would occupy the same space in the globe A as the steam of weight w; let μ be the specific volume of that steam, then—

$$\mu = \frac{W}{w}$$

In the adjoining wood cuts, Fig. 2 is an elevation, and Fig. 3 a section of the apparatus used for pressures above that of the atmosphere. A is the glass globe, about $5\frac{1}{4}$in. diameter, for the reception of the weighed portion of water drawn out into a stem about 32in. long and $\frac{5}{8}$in. diameter; B is the copper boiler forming the steam bath in which the globe was heated uniformly; the copper boiler is prolonged by a strong glass tube o, $1\frac{3}{4}$in. diameter, hermetically sealed at the bottom and securely fixed to the boiler by means of the stuffing box, s; this outer tube was steeped in an oil bath C, made of blown glass, 20in. long, resting in a sand bath l, which was supported on a tripod m m. The copper boiler was heated by a spiral coil of jets of gas e e, and the oil bath by means of a large wire gauze lamp h, protected from draughts by a ring of sheet-iron k; and the temperature thus obtained and distributed uniformly through the glass tube and steam bath was measured by a thermometer placed in each; a stop cock p was provided, through which the steam could be blown off, and on the top of the boiler was placed a Schaeffer's gauge for roughly indicating the pressure. The two mercury columns, the outer in the tube o, and the inner in the globe stem i, separating the water in the steam bath from that in the globe, form the saturation gauge.



A series of file marks were made upon the globe stem to denote various capacities of the globe and stem, and the column levels were read off to a hundredth of an inch by means of a cathetometer f, consisting of a small telescope with sight wires sliding upon an iron stem divided into inches and tenths, the sliding block carrying, at the same time, a vernier.

In order to make sure that the whole of the water introduced into the globe stem be converted into steam, it was at once superheated and then allowed to cool until the maximum temperature of saturation was reached, a precautionary measure rendered necessary by the fact that a vapour near the point of liquefaction has the power of retaining suspended, in it a portion of the liquid in the shape of mist; and that the attraction between water and glass is such as to cause the latter to retain in contact with it a film of water, at a temperature at which it would be vaporised but for this power of attraction.

The results of the experiments thus conducted, and in which Regnault's tables were used for the exact determination of the pressures, invariably showed greater densities and smaller volumes than are obtained by the combination of the laws of Boyle and of Gay-Lussac; but we do not reproduce the empirical formula constructed by Messrs. Fairbairn and Tate, for the tabulation of their results, because it can be made use of only in conjunction with a summary of the observations that had to be taken during each individual experiment, which our space will not permit to detail here. In order, however, to enable the reader to compare the results of the various theories and experiments to which we have briefly alluded, and in order, at the same time, to supply the practical want of a correct series of relative volumes of steam, at various temperatures and pressures, we have embodied an abstract of these results in the accompanying table. After a careful comparison of the results contained therein, it must be conceded that Dr. Fairbairn's experiments, so far as they have been carried, verify the conclusions arrived at by Dr. Rankine through the thermo-dynamic theory; and the slight differences of volume shown in the two columns under consideration must be accounted for by the difficulty of manipulation in experiments of so delicate a nature, and may, perhaps, be looked for as much in Regnault's experiments on the total and sensible heat of steam, as in Fairbairn's direct measurement of the relative volume of steam. It is to be hoped that this latter series of experiments will soon be extended to the higher pressures, as was originally intended.

TABLE OF RELATIVE VOLUMES WITH TEMPERATURES, PRESSURES, AND LATENT HEAT OF EVAPORATION.

Pressures in lbs. per sq. in.	Temperatures.		Relative Volumes as given by				Latent Heat of Evaporation.
	Fahrenheit.	Centigrade.	Perfect Gas Theory.	Pambour.	Rankine.	Fairbairn.	
lb.	Deg.	Deg.					Units.
10·16	194	90	2387	....	2325·9	2320	978·3
12·26	203	95	2005	....	1951·4	1950	972·0
14·70	212	100	1696	1669	1645·5	1635	965·7
17·53	221	105	1457	1403	1394·6	1380	959·3
20·80	230	110	1210	1211	1187·9	1170	952·9
24·54	239	115	1079	1047	1016·3	995	946·5
28·83	248	120	937·2	911	873·9	855	940·1
33·71	257	125	817·2	794	754·7	736	935·6
39·25	266	130	710·8	692	654·2	640	927·2
45·49	275	135	619	606	569·6	560	920·8
52·52	284	140	543	531	501·7	485	914·4
60·10	293	145	474·6	466	436·5	428	907·8
69·21	302	150	419	410	384·1	378	901·2
79·03	311	155	392	362	339·1	332	894·9
89·86	320	160	328	320	300·6	....	888·5
101·90	329	165	295	284	267·2	....	881·8
115·10	338	170	265·6	252	238·1	....	875·2
129·80	347	175	238·9	225	212·9	....	868·7
145·80	356	180	211·6	201	190·8	....	862·2
163·30	365	185	194·6	180	171·5	....	855·5
182·40	374	190	176	....	154·6	....	848·8
203·3	383	195	159·9	....	140·2	....	842·3
225·9	392	200	145·3	....	126·4	....	835·7

On the other hand, it cannot escape the reader's eye how closely the volumes obtained by Pambour's formula keep to those given by Rankine; and, when we remember that the experiments upon which this formula was based were made 25 years ago, probably with comparatively imperfect means of observation, we cannot but pay a passing tribute of respect to the penetrating mind from which it has proceeded; yet has it been almost totally ignored, and especially so in France.

As for the importance of the subject, that cannot fail to force itself upon the reader's mind when, upon comparing Rankine's volumes with those commonly in use, it is found that the difference, which amounts to $\frac{1}{35}$ of the whole volume at the temperature of 212°, goes steadily increasing until it reaches the almost incredible amount of $\frac{1}{6}$th of the whole volume at the temperature of 400°.

(*To be continued.*)

ABSTRACT OF ENGINEER'S LOG OF THE "GREAT EASTERN."—TENTH VOYAGE FROM NEW YORK TO LIVERPOOL, SEPTEMBER, 1863.

Date each day, ending at Noon.	PADDLE ENGINES. Revolutions of Engines each day.	PADDLE ENGINES. Average Revolutions per minute.	PADDLE ENGINES. Average Pressure of Stm. in Engine-room.	PADDLE ENGINES. Tons of Coal used each day.	SCREW ENGINES. Revolutions of Engines each day.	SCREW ENGINES. Average Revolutions per minute.	SCREW ENGINES. Average Pressure of Stm. in Engine-room.	SCREW ENGINES. Tons of Coal used each day.	Total quantity of Coal used each day.	Number of Knots run by Paddle Engines.	Number of Knots run by Screw Engines.	Distance run by Ship in Knots.	Latitude.	Longitude.	Course.	Barometer.	Observations on Rolling of Ship. Inclination to windw.	Observations on Rolling of Ship. Inclination to leeward	Observations on Rolling of Ship. No. of oscil. per min.	General Remarks.
			lbs.	Tons			lbs.	Tons	Tons	K.	K.	K.				inches.	deg.	deg.		
Sept. 8 ...	...	...	...	30	840	...	...	40	70	...	...	...	...	...	...	...	...	...	...	Sept. 8, at 11.30 a.m., started screw engines ahead slow.
Sept. 9 ...	12,222	9·0	21	117	42,360	31·04	15	157	274	294	305	270	40·37 N.	68·44 W.	N. 8· E.	30·00	...	...	...	Sept. 9, at 1.10 p.m., started paddle engines ahead slow; at 2 p.m., full speed paddle and screw engines; at 9.50 p.m., stopped paddle and screw engines, to discharge pilot, off Montauk Point; at 10.5 p.m., full speed; light S.S.W. breeze; sea smooth.
Sept. 10 ...	12,627	9·0	21	127	44,990	31·7	16	164	291	307	323	265	41·45 N.	63·33 W.	N. 77· W.	30·02	...	...	...	Sept. 10, strong N.E. breeze and heavy sea running.
Sept. 11 ...	11,420	8·13	21	126	44,460	32·	16	163	289	270	327	249	42·31 N.	58·4 W.	N. 78·39 E.	30·02	...	...	...	Sept. 11, fresh E.N.E. breeze and heavy sea running.
Sept. 12 ...	12,497	9·65	20	121	44,780	32·	16	165	286	364	325	246	44·12 N.	52·58 W.	N. 65·34 E.	30·00	...	...	...	Sept. 12, fresh N.E. to N. breeze and heavy swell.
Sept. 13 ...	13,639	10·26	19½	126	46,680	33·	16½	167	293	327	335	285	45·57 N.	46·45 W.	N. 68·22 E.	30·01	...	...	...	Sept. 13, light variable breeze and heavy swell; passed a large iceberg.
Sept. 14 ...	14,407	10·22	21	126	48,350	34·45	18	166	292	345	349	280	47·42 N.	40·26 W.	N. 67·53 E.	30·04	...	...	...	Sept. 14, light S.W. breeze and sea smooth.
Sept. 15 ...	14,406	10·16	21	120	48,560	34·44	18	169	289	346	349	296	49·5 N.	33·18 W.	N. 73·43 E.	30·01	...	...	...	Sept. 15, fresh S.E. breeze and heavy sea running.
Sept 16 ...	14,275	10·16	21	119	48,400	34·45	18	169	288	344	349	309	50·30 N.	25·41 W.	N. 74· E.	29·07	...	...	...	Sept. 16, strong S. breeze and heavy sea running; fore and aft and square sails set.
Sept. 17 ...	14,189	10·0	21	129	47,450	34·	18	166	295	338	340	265	50·44 N.	18·47 W.	N. 86·58 E.	29·08	...	...	...	Sept. 17, light S.S.W. breeze and heavy sea running; square sails set.
Sept. 18 ...	12,868	10·13	20	120	42,640	34·	18	150	270	301	318	248	51·35 N.	11·34 W.	N. 81·24 E.	29·09	...	...	...	Sept. 18, fresh W.S.W. breeze and heavy sea running; square sails set; at 2.15 a.m., stopped paddle and screw engines; at 2.16 a.m., reversed screw engines, full speed; came in collision with the ship *Jane*, of Liverpool.
Sept. 19 ...	14,692	10·5	20	126	45,020	32·	17	157	283	354	325	317	Steering by the land		Various.	29·04	...	...	...	Sept. 19, strong S. to S.W. breeze and heavy sea running; square sails set.
Sept. 20 ...	2,177	10·7	20	20	6,740	33·	18	27	47	85	82	65	...	...	...	...	...	...	...	Sept. 20, at 3.26 p.m., stopped engines off Point Lynass, to take pilot on board; all particulars of engines taken up to this time.
Total	149,419	9·33	20½	1407	511,270	32·	17	1860	3267	3615	3727	3095	...	...	...	...	...	...	...	

Actual time of steaming from New York to Bell Buoy, 11 days 3 hours. Distance run (by account), 3204 knots. Indicated horse-power of paddle engines, 3215·61; ditto screw engines, 4252·4 horse-power. Density of water in boilers, $1\frac{3}{4}$; 3·6 lbs. of coals per indicated horse-power per hour; vacuum in paddle engines, 25·5; ditto in screw engines, 26·0; extreme diameter of paddle wheel, 50·5ft.; effective diameter, 48·83ft. = 135·5ft. each revolution; screw, 44ft. pitch; average distance run per hour, 11·76 knots; immersion on leaving New York, 27ft. 3in forward; 29ft. 1in. aft.; immersion on arriving at Liverpool, 23ft. forward; 26ft. 6in. aft.; slip of paddle wheel, 12·8 per cent.; ditto screw, 16·28 per cent.; average daily consumption of coals by paddle engines, 126·41 tons; ditto screw engines, 167·12 tons; total daily consumption, 293·53 tons.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, NEWCASTLE, 1863.

NEWCASTLE AND GATESHEAD WATER SUPPLY.

By D. D. MAIN.

Newcastle has had its supply of water from various sources. Up to the year 1693 the inhabitants appear to have been chiefly supplied from wells and public fountains, communicating by means of conduits with the springs in the neighbourhood. Leland, the antiquarian, who visited the town in 1538, mentions three of these conduits for conveying fresh water to the fountains.

In 1647, it was discovered that the water which supplied one of the fountains was "hurtfull and dangerous to be used for food and dressinge of meat," and was ordered by the Common Council to be cut off. Then the sinking of collieries drained several of the springs, and in 1671 the scarcity was so great that an order of Common Council was issued for stopping the supply to all private taps. In 1693, one Cuthbert Dykes erected an engine and works, at a cost of £3500, for supplying the town from the River Tyne at Sandgate. But although these works continued in operation many years, the water obtained there was never acceptable to the inhabitants, who, in derision of the project, bestowed upon it the name of the "Folly." In 1697, a scheme of a much more comprehensive and satisfactory character was suggested by William Yarnold, an enterprising attorney from New Woodstock, in Oxfordshire, who came before the Mayor and made a proposal for supplying the town with good and wholesome water, which he proposed to convey from springs at a distance. The Corporation readily granted him a lease for 300 years of all the waste ground without the walls, but within the liberties of the town, empowered him to erect cisterns for holding the water, which were to be set on columns, and to construct any mill, waterhouse, wheel, or engine for forcing the water into the cisterns; to break up the pavement of the streets, and lay down pipes of lead or timber for the supply of water to the inhabitants. For this privilege Yarnold was to pay the Corporation 13*s*. 4*d*. per annum, convey good and wholesome water to all parts of the town where required, and allow the Mayor and Burgesses to cut and break his pipes to obtain water in case of fire; he was not to dig trenches in the streets to catch the water of the "River of Tyne," nor any of the springs or streams of the Town Moor and Castle Leazes, or that supplied the waterhouse of Cuthbert Dykes in Sandgate, or any other public pants, or fountains, of the town.

The site selected by Yarnold was about three miles north of Newcastle, adjoining what is still called the "Waterworks Farm," and it was necessary that he should have parliamentary power to enable him to enter upon the land between that place and Newcastle. He accordingly applied for and obtained an act in the tenth year of King William the Third (1698–9) for that purpose. The supply was obtained from a spring of remarkably fine water, and conveyed to the town by means of elmwood pipes. But it was soon found that the spring, though abundant in winter, yielded but a scanty supply in summer, and Yarnold, after contending with the difficulties of leakage and air locks, was at length obliged, in aid of the supply from his own works, to rent the Folly Works of Cuthbert Dykes at £40 a year. But the enterprise of Yarnold was not successful, and he ultimately disposed of it and left the town. In 1739 occurred a severe frost, which lasted many weeks, and entirely stopped the supply from Yarnold's works, and so damaged the pipes and cisterns that it was a considerable time before they could be again brought into working order. The "Folly" works suffered even more severely, and the proprietors, rather than repair it, abandoned the concern in disgust. After this period the proprietors of the waterworks obtained a lease of some valuable springs near Heworth, which added considerably to the supply, and in 1805 still further improved it by sinking a shaft on the Town Moor, and erecting a windmill to raise the water.

From these various sources the town continued to be supplied until the year 1831. The service was limited to three days per week, and the total quantity required was between 70,000 and 80,000 gallons per day for a population of 54,991 in Newcastle, and 15,860 in Gateshead, being about a gallon per head. But even that small quantity could not always be obtained.

The summer and autumn of 1831 had been remarkably dry, and had been succeeded by a mild, open winter, during which the Asiatic cholera for the first time made its appearance, and the Water Company's reservoirs were completely exhausted. In this emergency the company erected an engine, and pumped water from the River Tyne, conveying it in carts to their tenants. About 120 carts were employed in this way for six weeks.

In 1834, a new company obtained an Act of Parliament for supplying the town entirely from the River Tyne. They erected a powerful pumping engine, and laid down filter beds at Elswick, and, after purchasing the old works, continued to supply the town chiefly with Tyne water until the year 1845. By this latter company the consumption of water was greatly extended, and in 1845 had reached 700,000 gallons per day for a population of about 100,000, being about 7 gallons per head.

In 1845, the present company was established, and having in their turn purchased the existing works, continued to supply from them until their own were completed in October, 1848.

The works of the present company were designed to supersede the necessity of taking water from the River Tyne for the domestic use of the inhabitants. With this object, large reservoirs were formed near Harlow Hill, about 12 miles north-west of Newcastle, in which the water of the Whittle Burn was to be impounded. The drainage area was about 4340 acres, the capacity of the reservoirs 215,000,000 gallons, and the pipe to convey the water to Newcastle was 2ft. in diameter, and capable of conveying from 4½ to 5 million gallons per day. The amount of rainfall in the district was ascertained to be 24in. per annum, and it was assumed that, as in a district of ordinary character, one-third of the rainfall finds its way into the rivers; in a peculiar locality like Whittle Dean, where the declivities were rapid, the ground impervious, and vegetation scanty, the proportion of water which would be carried off by the natural channels of the country could not be taken at less than one-half.

Twelve inches of rain from an area of 4340 acres would have produced 3½ million gallons per day; and as the consumption was then only 700,000 gallons per day, and the reservoirs were laid out to contain ten months' supply, it appeared to the promoters that the works were of sufficient magnitude for many years to come, and that ample provision had been made against the longest drought ever likely to happen. The works were finished and brought into operation in October, 1848, and were found sufficient until the year 1850. The consumption had, in the mean time, increased to 1½ million gallons per day, and the number of persons supplied with water from 10,275 in 1845 to 62,740 at the end of 1849. The reservoirs could then, of course, hold only a supply for five months.

In the middle of February, 1850, a drought commenced which lasted till the end of October, during which the reservoir went continually down, and the company were obliged, before the end of the summer, to have recourse to the old works, and pump down from the Tyne in aid of the supply from the reservoirs. It was found that instead of the rain fall being 24in., that year it was only 17·68in., and instead of the available quantity being 12in., the water actually impounded only amounted to 6¼in. But it was also discovered that the rain available for water works falls almost entirely in the winter months, and that to take full advantage of the collecting ground the reservoirs should be of such magnitude as to impound all that falls, it being unsafe to depend on summer rains, which, unless they are heavy and continued, are quickly absorbed by the land. After very dry weather, it is not unusual for rain to fall to the depth of an inch, and none find its way to the reservoirs. If the reservoirs are not filled between November and February there is not much certainty afterward. But in a district like this, where the rainfall is so limited, and droughts extending to six and eight months are of frequent occurrence, even great reservoir storage is not altogether to be relied upon. In the experience of the Company there have been seasons in which the reservoirs have not been filled in the winter—one in particular deserves to be mentioned, that of 1857. From the 1st of December, 1857, to 1st May, 1858, only 3·08 inches of rain fell, and the reservoirs being pretty well run down at the end of the summer and not filled in the succeeding winter, the Company had to meet the spring and summer of 1858 with an almost empty exchequer.

The river Tyne has necessarily been the great resource in such seasons of drought. The present Company, although their works were constructed with a view to be independent of obtaining any portion of the supply from the Tyne, have preserved the power of resorting to it in case of necessity, a clause being inserted in their Acts of Parliament to enable them to do so with the concurrence of the Town Council. But the prejudice against the use of Tyne water is very great, nor is it difficult to account for it. It has either been resorted to in cases of great emergency, when little care could be taken to render it pure, or it has been taken at an objectionable place within the tidal influence. In 1831, when cholera was raging in the town, the Tyne water was lifted into carts, and, without any attempt at filtration, conveyed to the inhabitants. In 1850, and also in 1853, when cholera was once more amongst us, it was pumped at Elswick, beyond which the tide flows four or five miles.

The Tyne water is the softest in the district, and the chief objection to it arises from the stain of peat which it contracts from the moors in times of heavy rains. Whether this stain could be effectually removed by filtration, or by storing the water in large reservoirs, where it would bleach by exposure, has not been ascertained.

The present Company, several years ago, removed their pumping station on the Tyne, Newburn, beyond the flow of the tide; but they have also gone to great expense to supply the town independently of Tyne water. The original capital of £200,000 has been more than doubled, the reservoir storage has been increased from 215 to 530 million gallons, and the drainage area from 4340 to 17,300 acres, and in the last Session power was obtained to construct a large impounding reservoir, which will contain 500 or 600 millions more, gaugings having been previously taken, which show that in ordinary years a much larger quantity even than that can be obtained from the Company's present streams, if sufficient reservoir storage were provided. But it has been found in this town, as in others, that a great quantity of water is needlessly wasted, and, in order to prevent a state of things which, while it brings no benefit to the public, inflicts grievous loss on the Company, very stringent powers for preventing waste, and regulating tenants' fittings, have been obtained by their recent Act.

In some towns the consumption has, by the adoption of such measures, been reduced as low as 15 gallons per head.

If this Company could limit the supply to even 20 gallons per head, or about 100 gallons per house per day, which is certainly ample for all legitimate consumption, the quantity of water at present brought to the town would be sufficient for 250,000 people, and the present works would require no addition for many years to come.

When the Company commenced operations in 1845, the quantity consumed was 700,000 gallons per day, and the system of supply intermittent and irregular; but in their first Act of Parliament they voluntarily bound themselves to give constant service and unlimited supply. At that time the lowest rate for water was 10*s.* per annum, a scale of charge which prohibited the poor from having it in their houses at all; and the custom was to carry it from the street pants, or fountains, where it was retailed at a farthing per skeel of 3 gallons. By the present Company these pants were gradually abolished, the charge to a poor person, occupying a single room, was fixed at 5*s.* per annum; and where houses were let in several tenements, which is the case to a very great extent in this town, and the tenants could be supplied at one common tap, the Company was at the entire expense of the exterior and interior pipes and fittings. By these measures the supply became greatly extended, and the Company may now be said to supply the whole population where their pipes are laid.

The united population of Newcastle and Gateshead, and of the adjacent villages, supplied by the Company, is about 165,000, and the gross daily supply is about 4,700,000 gallons.

The total daily consumption is, therefore, about 28 gallons per head, one-fourth of which is consumed by railways and manufactories, and for trade purposes generally, leaving 21 gallons per head for domestic consumption.

In 1854 the water of the different streams diverted into the Company's reservoirs, and used for the supply of the town, was tested for hardness by Dr. Smith, of Manchester, with the following results:—Whittle Burn, 11·7 degrees; River Pont, 15·7; ditto in flood, 4·6; Fair Spring, 17·0; Moot Law Burn, 16·2; Hallowell Spring, 18·0; Hallington East Burn, 14·5; Hallington North Burn, 15·5; Small Burn, 12·5; River Tyne at Newburn, 8·7; in the reservoirs, 13·2; in Newcastle, 12·9 degrees.

Dr. Smith says, "These waters are all remarkably clear and free from any impurity, with the exception of the lime and magnesia constituting hardness."

The water has also been analysed by different analytical chemists, and found to be composed of the following ingredients:—

	Dr. Smith, March, 1854.	Dr. Letheby, February, 1863.
Carbonate of lime and magnesia.........	6·54	13·01
Sulphate of lime	6·13	4·65
Alkaline chloride	4·23	1·63
Oxide of iron and silica	·81	·83
Organic matter	2·38	1·21
Total solid contents in grains per imperial gallon	20·09	21·33

Dr. Letheby says, "The water is clear, colourless, and sparkling, of good flavour. Its hardness is rather great, amounting to 20 degrees of Clark's scale; and of these 6 were permanent. It has no action whatever on lead, and excepting that it is rather hard, it is a good water for domestic use."

The Tyne water has also been analysed, and shows the following ingredients:—

	Dr. Letheby, February, 1863.	Dr. Richardson, May, 1863.	Mr. Pattinson, January, 1863.
Carbonate of lime and magnesia	4·09	3·06	4·50
Sulphate of lime.....	2·49	1·22	·82
Alkaline chloride..................	1·22	·87	1·65
Oxide of iron and silica.........	0·44	·50	·58
Organic matter	1·39	2·63	2·05
Total solid contents in grains per imperial gallon	9·60	8·28	9·60

Of the Tyne water Dr. Letheby says, "It is a remarkably soft water, with a slightly brownish tint from humus or peat. It contains only 9·6 grains of solid matter in the gallon, and its hardness is only 7 degrees of Clark's scale. This is only half the degree of hardness of the London supply, and of this 4 degrees were removed by boiling for a quarter of an hour. I ascertained that the water was entirely without action on lead. It is a good water for manufacturing and domestic use."

Dr. Richardson says, "Our examination of the water from the River Tyne proves that, when taken from such a locality as Newburn, it is perfectly suited to the requirements of this district."

It only remains to mention the system of supply.

The Reservoirs at Whittle Dean are 360ft. above high water mark of the Tyne at Newcastle, but, on account of the friction along the 12 miles of main pipe, the water does not reach by gravitation the houses in the higher parts of the town.

About one-fifth of the whole supply has to be pumped to these high districts, and for that purpose the company have a 50-horse engine at Benwell Reservoir, whence the water is forced to a reservoir at Benwell Bank top, 400ft. above high water mark, which commands the most elevated houses in the town and suburbs.

THE RAILWAYS AND LOCOMOTIVES OF THE DISTRICTS ADJOINING THE RIVERS TYNE, WEAR, AND TEES.

By John F. Tone.

The Author stated in his Paper that the early tramroads seldom exceeded two or three miles in length. They were in use about 260 years ago, and were constructed mostly of oak and beech timber; and of this last extensive woods are in existence in the upper portions of the county of Northumberland, planted apparently about 120 years ago, up to which period the demand for timber for these tramroads had not entirely ceased.

Wooden tramroads were in general use till about 1780, although cast iron rails were first used about 1770; but up to this time the use of cast iron rails still continues in some of the older private railways. These, however, are now almost always replaced with wrought iron as they are worn out, and may soon become matters of history.

The conversion of the wooden tramroads into iron ones was the first great step in the improvement of railways which (after the introduction of wrought iron rails, in 1820) assumed their present shape, so far as the general principles of construction were concerned.

The railway system has been carried to a great extent in these districts; and so completely has the country been intersected with railways, public and private, that, on an area of about 666 square miles, comprised in the northern coal-field, there are only 122 square miles, or about one-fifth of the whole, at a greater distance than one mile, and only 221 square miles, or one-third of the whole, at a greater distance than half a mile from a railway, public or private.

The total length of the private railways in the entire district is 287 miles, and of the public railways constructed for the more immediate service of the district, exclusive of main lines, 387 miles—making together 674 miles.

The complete reticulation of the district, by means of these railways, will be understood from the circumstance that within the actual limits of the coal-field itself, comprising about 666 square miles, there are (including all lines general and local) 609 miles of railway, being nearly 1 mile of railway for each square mile of surface of the northern coal-field, in addition to the 1300 miles of underground railway, as estimated by Messrs. Wood and Taylor.

Previous to the introduction of tramroads, the old pack horse conveyed 3 cwt. at 3 miles per hour, and travelled on an average about 8 miles with his load.

The cost of this mode of conveyance was about $1\frac{1}{2}d.$ per cwt. per mile, or 2s. 6*d.* per ton per mile.

The introduction of macadamised roads increased the horse load from 3 cwt. to 18 cwt., and with the same mileage performed, the 2*s.* 6*d.* was reduced to $8\frac{1}{2}d.$ per ton per mile.

On the early wooden tramroads a horse averaged a load of 2 tons, further reducing the cost of haulage to $3\frac{3}{4}d.$ per ton per mile.

The immediate cost of actual haulage on private railways, exclusive of interest on capital and waggons, as before, in cases wherein horses, inclines, and fixed engines are intermixed, as circumstances require, and with quantities varying from 80,000 to 160,000 tons per annum, is found to amount to about ·7*d.* per ton per mile.

The cost by leading with a locomotive engine, costing 38*s.* per day, and with a load of 126 tons net on the ordinary local railways of the North of England, and in gradients reaching up to 1 in 100, travelling with a load about 35 miles per day, exclusive also of interest of engine and railway, and of waggons, as before, amounts to about ·11*d.* per ton per mile.

And on first-class gradients, and under most favourable circumstances, with loads of 350 tons, a mileage of 60 payable miles, at a cost of 48*s.* per day, this haulage may possibly be reduced to ·03*d.* per ton per mile; but this can but rarely be maintained in actual working.

Taking even ·1 of a penny as being the cost of the mechanical effect required to lead a ton of coals on a railway by locomotives we have reduced the cost to $\frac{1}{300}$ part of that by pack horses, and to $\frac{1}{37}$ part of the cost of wooden tramroads.

In order, however, more fully to estimate the relative commercial value of the different mode of haulage, as practised in these northern coal-fields, it will be necessary to include the other elements of expense, such as interest of capital, maintenance, and the cost of different descriptions of railway required in each case, and to compare the entire cost of the locomotive system with that of the fixed engines and inclines, as practised extensively in these districts.

1st. By horses, fixed engines, and inclines, intermixed with traffics, varying from 80,000 to 160,000 tons per annum, including waggons, maintenance, and renewals (and with interest on cost of line at £1500 per mile). The total expense of leading coals is found to amount to an average of 1·1*d.* per ton per mile. This is exclusive of cost of land, or of the way leaves paid in lieu thereof.

2nd. By fixed engines and inclines, without horse-power, this expense including, as before, with a yearly traffic up to 400,000 tons, and a distance up to 7 miles, the total cost amounts to ·54*d.* per ton per mile.

The particulars of this mode of leading are as follows, viz.:—Engines, inclines, and maintenance of way, in all ·43*d.* per ton per mile; interest on cost of railways and plant, 5 per cent per annum, waggon rates and contingencies, exclusive of land, ·11*d.* per ton per mile—making, as above, ·54*d.* per ton per mile.

By locomotives, and on railways of improved construction, including, as before, this cost with loads of about 126 tons, and with gradients up to 1 in 100, amounts, on an average of railways, to ·44*d.* per ton per mile; viz., the cost of maintaining and working a heavy locomotive engine, including repair, coke, water, stores, wages, &c., amounts in one year, on an average, to £600. To this must be added interest on capital, viz., £2300 at 5 per cent., £115; making the gross cost of an engine per annum £715, or say £720 per annum.

But to maintain three engines in working order on a railway, four must be kept; and this reduces the available number of working days to 234 throughout the year, costing 61*s.* for every day an engine works on the line, and travelling 35 payable miles with a load of about 120 to 130 tons, gives the locomotive power in conveyance of minerals, at the rate of about 12 to 13 miles per hour, the sum of ·17*d.* per ton per mile.

To this must be added the cost of waggons, and interest thereon, amounting to ·125*d.* per ton per mile; add interest, maintenance, and renewals of way, rates, &c., amounting in all to ·222*d.* per ton per mile, on a lead of 800,000 tons, making the cost of leading by locomotive power with full employment, ·517*d.* per ton per mile.

Thus it will be seen that the locomotive system, although capable of carrying a much greater mineral traffic, is not, on the whole, more economical than fixed engines and inclines, as now used in this district, unless in large traffic; indeed, where the traffic does not exceed 400,000 tons, and unless the gradients are better than 1 in 100, the fixed engine has the advantage; with gradients of 1 in 70 the two systems would be about on a par as regards expense. As the gradients improve or deteriorate, the locomotive gains or loses respectively, and at a million tons has a superiority.

The history of the rise and progress of the manufacture of locomotive engines especially connects itself with Newcastle-on-Tyne. The large manufactories of Messrs. Stephenson and Hawthorn have for many years been, and continue to be, of the highest repute.

In 1825, Messrs. Stephenson turned out the first locomotive on the Stockton and Darlington Railway, and, in 1829, completed the Rocket.

It is a remarkable circumstance that, notwithstanding the lapse of 34 years, during which the manufacture of locomotives has increased at a rate almost without precedent in similar matters, yet, in the general principles of mechanical construction, the present most improved locomotive remains very closely analogous to the Rocket.

The leading features of the Rocket were as follows:—Cylinder, diameter 8in.; stroke, 14in.; driving wheels, 4ft. 8in.; trailing wheels, 2ft. 10in.; heating surface, 144 square feet; weight of engine, $4\frac{1}{4}$ tons; weight of tender, $3\frac{1}{4}$ tons; horse-power, 40; evaporating power, 18·24 cubic feet water per hour; coke per cubic foot water evaporated, 11·7lbs.; maximum speed, 29 miles an hour; average speed, 13·8.

In the largest narrow gauge engines, now constructed, the heating surface has been increased from 144 to 1620 square feet; the weight of an engine from $4\frac{1}{4}$ to 38 tons; the horse-power from 40 to 1300.

Since the commencement of the manufacture of locomotives, about 2400 have been turned out by the manufacturers of Newcastle, and upwards of 900 of these have been sent abroad. Taking an average cost of £2000 from the commencement to this time, the gross value of the exported locomotives from Newcastle amounts to £1,800,000; adding those manufactured for use in Great Britain and Ireland at £1500 would give a further sum of £2,700,000; making the gross value of the locomotives from Newcastle to amount in all, since the commencement of the manufacture, to £4,500,000. Of the £4,500,000 nearly one-half is represented by material purchased by the manufacturers in various stages of completion; thus, work to the value of upwards of £2,000,000 has been furnished, by the manufacturers of Newcastle, to the other branches of industry connected with their trade.

EXTRACTS FROM PAPERS READ ON RIFLE ORDNANCE.

Mr. George Richards read a paper on this subject, which was illustrated by diagrams, representing the square-bored rifle gun and the round bored rail gun, of which the paper treated.

Various modifications of the bores were shown, such as substituting portions of circles for the angles or corners for preventing the risk of initial fracture, &c. (a quality inherent in the rifle principle generally). He adduced the authority of many eminent experimentalists as to the force exerted by the gases generated by gunpowder with its supposed "absolute velocity" of expansion, and to the fact of its pressure in all directions in an equal degree; and that, as a natural consequence, the greater the surface presented to it on any side the more in that direction would be felt (or obtained) an increased momentum. Hence the necessity of presenting a greater surface to the propelling gases to gain more velocity for projectiles, as well as to cause less bursting strain to be inflicted upon the bore of the gun, of all of which he gave illustrations by figures, and showed important considerations why this principle should be followed out in the construction of guns.

He stated that the purpose of the square bored gun was to give greater inital velocity to the projectiles than was attainable by any plan yet proposed, inasmuch as the area of the square bore was at least twenty per cent. more than that of the circular bore containing a shot of the same diameter, thereby exposing (by using a wad or sabot) a greater surface to the impact of the ignited powder.

The invention embraced two principles:—In the first place, the square-bore gun gave at least twenty per cent. more initial velocity than the round bore of the same diameter; and secondly, the method of obtaining increased velocity *to any extent* was by means of projections or *rails* on the interior of the surface of the round-bore gun, on which the projectile runs or slides, there being in them the necessary amount of twist to give the shot the rifle motion.

In both cases the sabots would be used to act as air-tight pistons, but might be dispensed with by using wedge-like shoulders on the periphery of the shot to fill up the angular spaces of the bore, and also to give the projectile the piston-like qualities sought to be obtained. This principle of presenting an increased surface to the propelling force of the gas, was considered to admit of an extra power, in aid of velocity, of about 15 tons for every additional square inch so obtained. Those forms of bore would admit of shot whose transverse section, might be square, hexagonal, octagonal, cylindrical, spherical, or other polygonal, or geometrical forms of areas.

In addition, Mr. Richards showed a method of loading heavy ordnance (applicable to sea service) by means of a loading rod. The method of loading the gun was by means of the rod passing through a perforation in the breech of the gun, and thence to the muzzle. The cartridge used was also made with a perforation, through which the loading rod passes. The loading rod was quickly attached to the base of the projectile at the muzzle of the gun. The charge was quickly drawn into the chamber of the piece and disconnected in readiness for firing, and the breech was then closed by a simple apparatus. The object of this method of loading, is to acquire the advantages of the breech-loader, and to retain the strength of the muzzle loader. The ports, or embrasures, could be closed during the operation of loading, and the men at quarters thereby protected from the enemy's fire.

ABSTRACT HISTORY AND DEVELOPMENT OF THE ENGINEERING MANUFACTURES OF THE TYNE AND NEIGHBOURING DISTRICTS.

By Percy Westmacott, M. Inst. C.E., and J. F. Spencer, M. Inst. M.E.

The north-eastern districts of the United Kingdom, long pre-eminent for mining operations in coal, and more latterly ironstone, have also been gradually rising into importance as the seat of most extensive engineering manufactories.

The unlimited supply of coal, an intelligent, hard-working, and enterprising population, together with the engineering necessities of such a large mining district, and the advantage convenient seaports have combined to create a large and increasing demand for all classes of engineering manufactures.

As early as the year 1747 the Gateshead Iron Works were commenced, and the present proprietors, Messrs. Hawks, Crawshay, and Co., have now one of the largest engineering establishments on the Tyne.

In 1793, millwright work was undertaken at Chester-le-street, paper, lead, corn, and other mills being constructed and supplied to all parts of England, Scotland, Ireland, and abroad; in 1826, a large foundry business was added.

In 1809, the Walker Iron Works, owned by Messrs. Losh, Wilson, and Bell, were commenced, and, as in the two establishments previously mentioned, the variety and extent of engineering work rapidly increased, as the demand arose for an improved class of machinery and motive power.

Mr. Losh, the late senior partner of the firm, is well known in connection with the introduction of wrought iron railway wheels, an improvement that has materially tended to perfect the efficiency of the rolling stock. The manufacture of Losh's patent wheels was at one time a very large and important branch of the Walker Iron Works.

It may be interesting to notice, at the early date of 1784, the erection on the Tyne of one of Watt's steam engines, for the owners of Walker Colliery, by Boulton and Watt. Mr. Losh purchased this engine in 1805 for the Walker Alkali Company, and it may yet be seen working daily at Walker, with its wooden beam and bed plate, and sun and planet crank motion.

In 1817, Mr. Robert Hawthorn, the present senior partner of Messrs. R. and W. Hawthorn, established the Forth Bank Engine Works, receiving as a partner his brother William, in 1820. The increase from 8 men in 1817, to nearly 1000 in 1862, indicates very forcibly the progression of this well known establishment. (See Table A appendix.)

In 1830, Mr. T. D. Marshall, of South Shields, commenced the building of steam tugs and fitting them with machinery.

In 1838, the Hartlepool Iron Works were established by Messrs. Thomas Richardson and Sons; these works are now of considerable magnitude.

In 1844, the Tees Engine Works, now owned by Gilkes, Wilson, and Co., were established for the manufacture of large iron bridges and similar constructions, locomotives, marine and stationary steam engines, and foundry work.

In 1847, the Elswick Engine Works were commenced, with about 200 men, and, although then only engaged in the manufacture of hydraulic and general machinery, there has been a later period when, with the manufacture of the Armstrong guns (1858), the number of hands employed has amounted to upwards of 4000.

In 1847, Mr. Renoldson, of South Shields, established shops for the construction of engines and boilers for tug steamboats.

As the increasing commercial interests of this country, and the improvements matured in steam power, gave a fresh impetus to engineering manufacturers, the undoubted advantages and facilities of this district were appreciated and availed of by Messrs. Palmer Brothers in 1852, Messrs. Morrison and Co. in 1853, Messrs. Thompson in 1856, and Mr. David Joy, of Middlesboro', in 1862.

In referring briefly to the progress and present condition of the engineering manufacturers of the Tyne and neighbouring districts, it will be necessary to classify them under the following heads:—

1. General machine and mill work.
2. Stationary and steam engineering.
3. Locomotives.
4. Marine engineering.
5. Hydraulic machinery.
6. Iron bridges, viaducts, lighthouses, &c.

1. General Machine and Mill Work.

During the past 116 years, the following firms have contributed largely to the supply of first-class machine and mill work of all descriptions:—Messrs. Hawks, Crawshay, and Co., of Gateshead Iron Works; Thomas Murray and Co., Chester-le-street; Losh, Wilson, and Bell, Walker Iron Works; R. and W. Hawthorn, Forth Bank Engine Works; R. Stephenson and Co., South-street Engine Works; Thomas Richardson and Co., Hartlepool Iron Works; Gilkes, Wilson, and Co., Tees Engine Works; W. G. Armstrong and Co., Elswick Engine Works; Morrison and Co., Ouseburn Engine Works; Thompson and Co., Spring Gardens Engine Works. With reference to the magnitude of the work undertaken by some of the above firms, it may be stated of Messrs. Crawshay and Co., Losh, Wilson, and Bell, Thomas Murray and Co., W. G. Armstrong and Co., and Morrison and Co., that single castings have been supplied from 45 tons downwards, and there are capabilities for turning out single castings of even 60 tons.

As every description of paper, corn, lead, and other mills have been extensively constructed, it is impossible to refer to them in detail; but the erection of a self-acting crane for delivering ballast at St. Anthony's Quay, by Messrs. R. and W. Hawthorn, at the early date of 1820, is worthy of notice.

2. Stationary Steam Engineering.

Steam power was first practically utilised in mining operations, and its application was early introduced in the North-Eastern mining districts by several of the engineering firms before referred to; and the fact that the wants of a large mining district were almost exclusively supplied with steam power by local talent, and capital, is a satisfactory proof that there were the right men, at the right time, to aid by their engineering experience the resources and trade of the district.

Among the engineering specialities of this district may be mentioned many large winding and blowing engines. Messrs. Hawks, Crawshay, and Co. have cast and bored cylinders of 108in. diameter for this class of engines.

In 1822, Messrs. R. and W. Hawthorn first applied steam to drive their lathes, and in 1824 they constructed a 50 horse-power engine for the Plate Glass Works of Messrs. Cookson and Cuthbert; and this engine is still doing efficient duty. At this period the same firm also fitted a self-acting steam crane, for delivering ballast at Hebburn Quay, on the Tyne.

Several of the firms previously mentioned have extensively supplied steam cranes of various powers; Messrs. Thompson and Co. alone having made upwards of 200.

Messrs. Morrison and Co. are noted for their large steam hammers, several of which they have supplied to the Government, the Elswick Engine Works, and other large establishments; and they have them in their own works of 15 to 20 tons weight, together with 2 steam cranes capable of lifting 50 tons each.

Although not quite finished, yet, on account of its excessive magnitude, it is of some interest to note here that Messrs. Morrison and Co. are now engaged in completing a monster steam hammer for the Russian Government. The forging for the hammer piston is 40 tons, and the enlarged part of the same is 6ft. 6in. diameter, finished size. The total weight of this hammer, when completed, will be about 550 tons, the bed alone being 240 tons, and will be cast in three pieces in its final resting place; it is believed this will be by far the largest steam hammer in the world.

The application of steam power to underground haulage has been successfully introduced by Messrs. Thomas Murray and Co., of Chester-le-street, the steam being conveyed to engines underground from boilers placed above the surface.

A model of this application of steam power in Hetton Colliery was exhibited at the meeting; in this case there are a pair of 18in. cylinders, and 3ft. stroke, working four drums, all on separate shafts, for drawing on a plane and incline.

Messrs. Murray and Co. have lately erected two 200 horse-power condensing engines for winding at Ryhope New Winning; the cylinders are 68in. diameter and 7ft. stroke; these engines can deliver 2000 tons per day from a depth of 300 fathoms. The same firm also erected at North Seaton a winding and pumping engine cylinder, 60in. diameter, and 7ft. stroke, fitted with the first hollow plate iron beam.

Messrs. Losh, Wilson, and Bell were early in the field in the construction of steam engines for mills, collieries, and iron works. This firm have erected a large pumping engine, about 30 years ago, for Friar's Goose; also, at later dates, a large pumping engine for the North Seaton Colliery—diameter of cylinder, 76in., and 8ft. stroke; 60in. double cylinder high pressure engines for the Burradon Colliery, and many engines for blast furnaces and winding, having steam cylinders of 38, 40, and 42in. diameter.

At the present time this firm is largely engaged in the manufacture of surface condensers for mill and other steam engines, in connection with Mr. J. F. Spencer, the patentee of certain improvements in their application to existing and new engines.

This short and limited notice of such an important subject as the development of stationary steam engineering, can only serve to indicate in a very limited degree the engineering capabilities of the district.

3. Locomotive Engineering.

To this district belongs the undoubted honour of being the birthplace of the locomotive, and this fact must ever be recorded, when the names of Trevethick and Stephenson appear on the page of history.

In a paper written expressly to record the contribution of the north-east of England to the engineering talent of the country, it would be simply unjust to forget, in the now almost world-wide extension of locomotive manufacture, the Stephenson "Rocket" of 1829, or the Hawthorn "Comet" of 1835. The latter engine, which was used at the opening of the Newcastle and Carlisle Railway, can still be seen in daily work at the saw mills of the Forth Bank Engine Works.

In Table C, in the appendix, will be seen the number of locomotives and tenders manufactured by the several local firms; and it will be sufficient here to state, generally, that during the past 34 years upwards of 2400 locomotives have been constructed by R. Stephenson and Co., R. and W. Hawthorn, Gilkes, Wilson, and Co., and Sir W. G. Armstrong and Co.

In the above number are included all the known varieties of the locomotive, from the comparatively small tank engine to those magnificent specimens, constructed by Messrs. R. Stephenson and Co., for the late Viceroy of Egypt (photographs of these engines were exhibited).

4. Marine Engineering.

It would display an unwarrantable indifference to the birth and progress of great improvements, if reference was not made to the first practical application of steam power on the Tyne for towing purposes, more especially as the date of such application was almost coeval with Henry Bell's "Comet," on the Clyde, in 1812.

It is also of interest, in an engineering point of view, to place on record the names of those local firms who were the earliest in the field in making and fitting the first steam engines for Tyne tugs.

In 1814, the first steam tug, the "Perseverance," was fitted and started on the Tyne, there being at that time only 17 steamboats in existence; and Table B, in the appendix, gives the particulars of the introduction of steam for towing purposes on the Tyne, from 1814 to June, 1822; in this table it will be seen that the now existing firms of R. and W. Hawthorn firstly, and Hawks and Co. secondly, made and fitted steam engines for tugs as early as the years 1820 and 1821.

This reference to the beginning of steam navigation, and manufacture of marine engines on the Tyne, is the more important from the well known fact that almost all the ports of the United Kingdom, as well as those of foreign countries, have to the present day come to the Tyne for their steam tugs. From this fact it may be fairly assumed that the Tyne engineers have from the first supplied a most important want in a manner that has defied competition; and even now it is difficult to suggest any important improvement in the class of engine that has been working in these tugs during the past 40 years.

Some additional force is given to the last statements by the fact that, at the present time, there are upwards of 250 of what may be aptly termed "native steam tugs" employed on the Tyne, besides nearly 100 more in the ports of Sunderland, Stockton, Middlesborough, and Hartlepool; and the engines in all these are almost identical in type with those fitted in 1820.

Among the evident causes for the rapid extension of marine engine construction in the ports of this district are the early introduction of steam power for towing purposes, and, more lately, the increasing substitution of steam for sails, in the coal carrying trade, leading to the introduction of screw colliers; these may be fairly considered, with respect to this district, as native productions, and, further, they have proved stepping stones to the construction of the higher classes, and larger powers, of marine engines.

As before stated, Messrs. R. and W. Hawthorn were the first of the now existing firms to make engines for steamboats; and during the past 10 years especially they have been extensively engaged in fitting marine engines, both paddle and screw, up to 250 horse-power. In 1859 they applied most successfully to the *Frankfort*, 100 horse-power, of Liverpool, Mr. J. F. Spencer's system of surface condensation, and they have, more lately, applied the same arrangement with equal success to a pair of 140 horse-power screw engines they made and fitted into the *London*, for the Cadiz trade; the economy of fuel being considerable.

The same firm have also supplied Her Majesty's Government with 150 horse-power horizontal screw engines for H.M.S. *Shearwater;* these engines are fitted with separate expansion valves, worked by a second link.

Messrs. Hawks, Crawshay, and Co. have constructed several pairs of marine engines, paddle and screw, for river and sea service, and they date the commencement of this class of work as early as 1821.

In 1830, Mr. T. D. Marshall, of South Shields, commenced building and fitting steam tugs, and out of the 600 engines this firm have made since that date, upwards of 300 have been fitted in steam tugs. Marshall's steam tugs being well known in every port. The present firm of Marshall Brothers are still largely engaged in the construction of paddle and screw engines.

The names of Renoldson, Almond, and Kepple are also well known as producers of steam tug engines on a large scale; and it may be safely stated that upwards of 1000 tug engines have been made and fitted on the Tyne.

Messrs. Thomas Richardson and Co., of Hartlepool, have paid much attention to marine engineering, and are now engaged in perfecting several improvements therein. The extent of their establishment can be seen by reference to Table C, in the appendix.

Messrs. R. Stephenson and Co. have employed a large portion of their extensive establishment in the construction of marine engines; and, in addition to a long list of engines fitted, of various sizes, they put on board a Sardinian frigate a pair of 250 horse-power horizontal screw engines for the Sardinian Government.

In 1852, Messrs. Palmer Brothers established the Jarrow Engine Works, where have been manufactured, and fitted on board, a considerable number of marine engines, paddle and screw, and some of them of large power, having 90 and 80in. cylinders.

During the past 18 months this firm has introduced surface condensation into several pairs of engines, adopting an American plan for jointing the tubes. These engines are reported satisfactory for duty and economy of fuel, and there are several pairs in hand on the same plan, having 63 and 60in. cylinders.

Of the latest and most successful of this firm's engines may be mentioned those of the *Georgia*, having 60in. cylinders, giving a high speed and small consumption of fuel.

Messrs. Morrison and Co., of the Ouseburn Engine Works, have given much attention to the construction of marine engines, up to 250 horse-power, and have applied Hall's surface condensers, separate expansion gear, and steam jackets with much success. The mail steamship *Auckland,* with the improved engines referred to of 150 horse-power, has proved on her trial and economical and successful ship.

Messrs. Thompson and Co., of the Spring Gardens' Engine Works, have, especially since 1856, been largely engaged in the construction of marine engines up to 200 horse-power, and they have also paid some attention to economy of fuel.

Messrs. Gilkes, Wilson, and Co., of Middlesboro', and Mr. G. Clark, of Sunderland, are also engaged in marine engine construction, but have not furnished any information as to extent or speciality.

In this limited notice of what is now a most important branch of engineering industry in this district, it is important to state that the North Country engineer has to provide a larger and more powerful marine engine at a less cost per horse-power than the engineer on the Thames; and this unjust difference has tended materially to check in this district the manufacture of the higher class of marine engines.

Finally, it may be confidently stated there is a general desire among the North Country engineers, that the system of quality of workmanship following price should be superseded by price following quality of workmanship.

Several of the large firms just referred to have every capability, in extent and convenience of shops and tools, for supplying the largest engines that may be required for her Majesty's navy or mail steamships.

5. Hydraulic Engineering.

It will be necessary under this head to refer separately—first, to the application of machinery to pumping, either for removing or supplying water; and secondly, to the application of machinery in using water as a motive power.

Extensive mining necessities require the constant attention of the mechanical engineer, especially to provide large and capable machinery for discharging water from great depths; and it is matter of much satisfaction when such machinery can be designed and applied on the spot.

The following brief reference to the productions of local firms, in addition to the supply of machinery for waterworks, &c., will clearly show that this district has reaped the full benefit of such local designs and applications.

Messrs. Thomas Murray and Co., of Chester-le-street, have applied steam power extensively to pumping for colliery purposes, and completed some of the largest colliery pumping engines in the district, some of them being 200 horse-power, with 60in. and 68in. steam cylinders.

Messrs. R. and W. Hawthorn were very early in the field in the construction of large engines for pumping, and in 1834 they erected a single-acting pumping engine, with 55in. cylinder and 8ft. stroke, for the Newcastle Subscription Water Company. This engine was the first erected in the neighbourhood with steam jackets and valves on the Cornish principle; it was at a later date (1854) converted into a double-acting engine, and is now doing duty at Newburn.

In 1845 several large pumping and winding engines were erected by the same firm at the various collieries in the North of England, among which was a powerful pumping engine of 250 nominal horse-power, at Walbottle Colliery, on the Tyne, with steam cylinders 77in. diameter and 10ft. stroke; it was erected to drain a large coal-field area, where it is now working.

In 1847–8 several first-class waterworks' engines were manufactured and erected by the same firm in the towns of Newcastle, Derby, Nottingham, Wolverhampton, Southampton, and Brighton; and in 1858–9 they erected powerful double-acting, combined, high and low pressure, and rotative beam engines, at the works of the Nottingham Waterworks Company, the Coventry Waterworks Company, and at Altona, near Hamburgh, for the supply of that city with water, under the direction of Thomas Hawksley, Esq., C.E. Those last-named engines performed a duty of 110 millions, with 112lbs. of coals, the consumption being $2\frac{1}{2}$lbs. per indicated horse-power. An arrangement for causing the governor

to act directly upon the steam valves was introduced in these engines with perfect success, giving them great steadiness in working, and effecting a considerable saving in the quantity of steam used.

Messrs. Hawks, Crawshay, and Co., of Gateshead, have constructed and erected at the Hull Waterworks the largest pumping engine that has been made in this district.

The steam cylinder is 85in. diameter, and stroke 10ft. 6in.; the plunger pump being 34½in. diameter, and the same stroke as the steam cylinders.

This beam engine is single acting, and capable of lifting nearly 2 tons of water 174ft. high each stroke.

The same firm has also erected a large pumping engine for the waterworks at Scarborough. The steam cylinder is 45in. diameter, and stroke 8ft.; this is a single acting beam engine, worked expansively.

Messrs. Morrison and Co., of the Ouseburn Engine Works, have made several large pumping engines. One pair was erected at Cleadon-lane, for the Sunderland and South Shields Water Company. There are two steam cylinders, each 60in. diameter, and stroke 8ft., worked expansively.

Messrs. Losh, Wilson, and Bell have also erected several large colliery pumping engines.

Messrs. Sir W. G. Armstrong and Co., in addition to their extensive application of machinery for applying water as a motive power, have constructed the engines for the Durham Water Works, together with other pumping engines for collieries; and they have been successful in introducing a self-acting valve to waterworks' supply pipes that effectually shuts off the supply in case of a pipe bursting.

Of the second division, or the use of water as a motive power, there is a distinct speciality of manufacture pertaining to this district in the machinery produced by Sir W. G. Armstrong and Co., at the Elswick Engine Works; and the following somewhat full reference to this subject may be justified by the fact, that the manufacture of this class of machinery has been exclusively confined to this district.

At the meeting of the British Association for the Advancement of Science, held in the year 1854, Sir William (then Mr.) Armstrong read a paper on the "Application of Water Pressure Machinery," wherein he described the origin and principles of his invention in the system of hydraulic machinery now referred to.

In the further extension, since that period, of this class of machinery, many improvements have arisen, the principles as then expounded, however, remaining the same.

The application of water power is classed under two heads, viz., the one where the pressure is obtained from natural sources; the other, where it is generated by artificial means. The employment of the former has remained limited, owing to its being confined to districts less accessible for the erection of works; and, therefore, the important and extended application of hydraulic machinery which has taken place, in nearly all the principal docks, railways, and Government establishments in this country, is due to the invention of the "Accumulator," for producing artificial pressure which is usually made equal in effect to a head of water of about 1500ft.

This high pressure system has been adopted with economy to a great variety of purposes, such as to cranage, waggon-lifts, coal-drops, hoists, and tipping machines; to the working of turntables, traversing machines, hauling machines, capstans, &c.; but in no one branch of labour, perhaps, has this economy been more exemplified than in the loading and discharge of vessels, particularly those employed in the coal trade.

Nearly 1800 hydraulic cranes, hoists, and other machines of this description, have been applied, and 174 steam engines, having a collective power of more than 5200 horse power, are employed in supplying the pressure required for working them. In addition to these, 177 hydraulic engines of various forms and powers have been produced, and 23 movable bridges are worked by hydraulic machines.

The most novel and noticeable arrangement for the discharge of coal from vessels, by means of hydraulic machinery, is to be seen on board a vessel belonging to Mr. Cory, moored in the River Thames. This vessel, originally built for other purposes, has been converted into a floating wharf, and is supplied with a steam pumping engine, accumulator, 6 hydraulic cranes (which weigh the coal at the same time), 2 hydraulic capstans, and a variety of appurtenances for facilitating the work by day and by night. Rapidity of discharge is the great feature of this scheme—steam colliers carrying 1200 tons of coal are delivered in 10 hours. Such vessels, plying between the Tyne and the Thames, have accomplished the voyage there and back in 96 hours; having loaded and discharged each cargo in one tide, and made the passage in three tides each way. Two such vessels can be delivered at the same time alongside Mr. Cory's floating wharf, thus rendering the power equal to the discharge of about 5000 tons of coal in the 24 hours.

The application of hydraulic hoists for shipping coal has met the difficulty formerly felt in loading from low levels, at a comparatively moderate cost, may be seen from the following figures:—

At the Newport Docks, Monmouthshire, in the year 1862, 219,185 tons of coal were shipped from three hydraulic hoists worked by six men. The sum paid in wages, stores, and repairs, amounted to £501 6s. 2d. The cost of supplying the pressure amounted to about £250, which gives a charge of about 0·276 of a penny per ton for the pressure, and 0·552 of a penny per ton for wages, stores, and repairs. These figures are exclusive of the interest upon the outlay of capital. Before the introduction of hydraulic machinery at these docks, the cost of loading coals by hand amounted to between 5*d.* and 7*d.* per ton.

In point of dispatch the hydraulic is equal with the gravitation system, both being limited by the labour of trimming the coal in the hold of the vessel.

The most remarkable application of a hydraulic machine for loading coals is the one now constructing at Goole Docks, in connection with the system adopted by Mr. Bartholemew for the coal traffic upon the Aire and Calder Canal. The barges, carrying 33 tons of coal each, will be lifted by this machine out of the water, and their contents tilted directly into the hold of the vessel to be laden.

Recent improvements in the construction of rotatory engines have so simplified and reduced their size, that the application of this class of engines is rapidly extending. A 7 horse-power hydraulic engine, worked from the ordinary high (accumulator) pressure, occupies a space of 2¼ft. square by 9in. deep. Such engines are now being applied directly to new, as well as to the existing dock gate crabs at the Liverpool Docks, without at all disturbing the present arrangement of the hand power gear of these crabs, which can thus still be used by hand in cases of emergency. Other engines are similarly applied directly to the crabs of handpower cranes, swing bridges, and other hauling appliances, to capstans, machines for planing armour plates, &c.

The latest improvement in hydraulic engines consists in making them with variable power, so that their consumption of water may be the better proportioned to meet any fluctuations in the amount of work to be done. An engine of this description, capable of being worked up to 17 horse-power, under under an ordinary accumulator pressure of 700lbs. per square inch, was exhibited in the collection of models brought together in this town during the meeting of the Association.

The advantage of the system of storing up pressure in accumulators, so that a great force can be quickly brought to bear upon heavy masses to be rapidly moved for a limited distance, is well exemplified in its application to movable bridges; and the importance is the more felt in situations where traffic would be seriously impeded by slow action, as, for instance, at the part of the Swansea and Neath Railway, where the line crosses the mouth of the river, and the entrance to the dock in Swansea. The communication of the line is kept up over these two points by hydraulic draw bridges. The time occupied in lifting and drawing back the largest bridge—which has a space of 75ft. and weighs 260 tons—is under 1¾ minutes.

At Wisbeach, where the plan of storing up pressure in an accumulator by hand pumps is resorted to, a bridge weighing 150 tons can be opened or closed in less than two minutes.

In noticing the application of water pressure, derived from natural sources, to the working of machines upon the system introduced by Sir William Armstrong, no better reference can be made than to the complete and extensive works erected upon the lead mines at Allenheads. Hydraulic machinery is therein employed in raising materials from mines; in giving motion to machines for washing, separating, and crushing ore; in pumping water, and driving saw mills and the machinery of a workshop.

The most recent application of water power at these mines deserves especial notice.

The district upon which the several new works are opened is void of falls of sufficient altitude for working the engines and machines directly, but a river runs through the district which is suitable for overshort wheels; and through such mediums the stream is made to force water into accumulators, thus generating an intensified power, which is utilized by compact machines distributed in situations most convenient for their several duties. The principal object sought in thus intensifying the pressure is to lessen the size of the pipes, cylinders, and valves of the machines, and to gain more rapid action, and also by so reducing the size of parts to effect a saving in outlay upon the work generally.

6. IRON BRIDGES, VIADUCTS, LIGHTHOUSES, &c.

The art and manufacture of iron bridge building, and of other similar iron structures, which form such an important feature in railway construction and harbour improvements, are followed to a considerable extent by several engineering firms in this district.

The following brief notice of some of the most important of these works can only be taken as an index of the resources of the district in this direction.

That noble structure which spans the River Tyne, and forms a communication of road and rail, at a high level, between the towns of Newcastle and Gateshead, emanated, as is well known, from the same practical mind and genius that with dauntless courage and rare skill threw railway bridges across the Menai Straits and the St. Lawrence River.

The superstructure of the high level bridge was executed by Messrs. Hawks, Crawshay, and Sons, of Gateshead. This firm has recently erected the cast iron bridge at York, from the designs of Mr. Page; it spans the river Ouse in one arch of 172ft. in width. Also, the new bridge at Sunderland, which consists of a single arch of about 237ft. span, at a level of 90ft. above high water mark. A melancholy interest is attached to this bridge, it being one of the very last works designed and undertaken by the late Robert Stephenson.

Messrs. Hawks, Crawshay, and Co. likewise constructed the wrought iron gates for the Northumberland Docks, and the iron lighthouses at Gunfleet, Calais, and Harwich; and supplied the materials for the iron pier at Madras, a work of considerable magnitude.

Messrs. Robert Stephenson and Co. have been engaged upon the construction of wrought iron gates for docks, and have made 38 wrought iron bridges, among which, as most noteworthy, may be mentioned the Kaffie Azzayat Bridge, over the River Nile. The total length of this bridge is 1807ft. It is composed of four fixed openings, each 114ft. wide, and two swing openings each 80ft. wide. The girders are box shaped, and are carried upon wrought iron cylinders, 10ft. diameter, and about 90ft. long. The gross weight of this bridge, with the supporting cylinders, amounts to 2631 tons.

The firm of Gilkes, Wilson, and Co., of Middlesboro', have recently executed, from the designs of Mr. T. Bouch, some lattice bridges for the South Durham

and Lancashire Union Railway, of a peculiar light and cheap construction. Of these the Beelah Viaduct may be looked upon as the most interesting specimens of construction and workmanship. (Several models of this bridge were exhibited at the meeting.) It is constructed upon a somewhat similar plan to the celebrated Crumlin Viaduct, from which, however, it differs in many essential points.

This Beelah Viaduct consists of 15 pieces, composed of hollow columns. The span of the lattice girders forming the roadway is 60ft. in width. The total length is 1000ft., and the greatest depth from the rail to the ground is 195ft. The quantity of materials used in construction consists of:—

776 tons of cast iron.
398 tons of wrought iron.
12,343 cubic feet of Memel timber for roadway.

Messrs. Sir W. G. Armstrong and Co. have been engaged extensively in designing and manufacturing iron bridges. They have constructed 25 movable, and 44 fixed bridges. With one or two exceptions the whole of the former are worked upon the hydraulic system introduced by them.

The swing and draw bridges at the Birkenhead, Liverpool, and London Docks, and upon the Swansea and Neath, and Great Western Railways, are among the most noteworthy of this class. The largest fixed bridge constructed by this firm is the one which crosses the River Somme in India, made after the plans of Mr. G. Rendel, now one of the partners of this firm. Being about one mile in length, it boasts of being the longest bridge but one in the world. It is formed with 28 spans. The girders, carrying a railway platform above, and a common roadway beneath, are of the lattice construction, the top section being composed of wrought iron boxes, and the lower section of tension bars. The girders are carried upon brick piers.

The total weight of the bridge, including the pier superstructures, which are of iron, is about 4000 tons.

Sir W. G. Armstrong and Co. have also turned out from their works, caissons, dock gates, pontoons, coffer dams, saddle-back barges, wrought iron dredges, and a variety of works of this description.

There are many other firms in the district engaged in constructing similar classes of work to those before referred to. Enough, however, has been said to show the important position which this district holds in this branch of industry, the history and development of which have been shortly traced in this paper.

APPENDIX.—Table A.

Showing the average number of Men employed by Messrs. R. and W. Hawthorn from the commencement of their Works, in 1817, to the year 1862.

Years.	Average Men.	Years.	Average Men.
1817	8 to 10	1838 to 1842	511
1818 to 1822	42	1843 to 1847	726
1823 to 1827	108	1848 to 1852	907
1828 to 1832	216	1853 to 1857	890
1833 to 1837	318	1858 to 1862	984

Table B.

Statistics having reference to the introduction of Steam Power for towing purposes on the Tyne.

Date.	Name of Steamer.	H.P.	Engine Builder.	Total number employed in the United Kingdom.
1814	Perseverance	3	Crowther	17
1815	Swift	3	....	21
1816	Eagle	20	Watt......	31
1817	Enterprise	5	Robson ...	40
1818	Speedwell	10	Robson ...	52
1819	Hope	6	Robson ...	64
1819	Swift	3	Robson ...	65
1820	Tyne	10	Robson ...	78
1820	Two Brothers....................	9	Robson ...	79
1820	Indefatigable	8	Hawthorn	80
1820	Duchess of Northumberland	10	Hawthorn	81
1821	Navigator	18	Hawthorn	117
1821	Safety	14	Hawks ...	118
1821	Union	4	Gibson ...	119
June, 1822	Lemington Packet	7	Hawthorn	148

Notes having reference to Table C.

4. Present works comprise 26 shops (including 2 extensive erecting shops with powerful travelling cranes), the tools and machinery in which consist of 19 planing machines, 55 lathes, 4 boring mills, 5 shaping machines, 28 drilling machines, 7 punching machines, 3 shearing machines, 1 rivetting machine, 3 plate-bending machines, 3 steam hammers, 22 cranes, 2 hydraulic presses, 1 lifting apparatus for loading boilers, &c., with winches to lift 40 tons, and other tools in proportion, 2 large steam hammers in the forge, 30 cwt. and 60 cwt. each.

5. Extent of works, about four acres.

7. The whole works cover an area of $4\frac{1}{4}$ acres, and consist of erecting shop, fitting and turning shops, iron and brass foundries, pattern shop, coppersmith shop, boilersmith shop, smith shop and 2 forges, with 3 steam hammers, 10, 15, and 50 cwt. each.

9. Extent of works, 9 acres.

11. The works consist of the usual machine, fitting, erecting, smith, and pattern shops, together with forge, boiler yard, and an extensive foundry for engineering and general castings.

12. Extent of works, about 10,000 square yards, and consist of forge, foundry, engine, and steam hammer shops. In the forge are 3 steam hammers, one of which is 15 tons, and can be increased to 20 tons, if necessary; also 2 steam cranes capable of lifting 50 tons each. The foundry has 2 travelling cranes, capable of lifting 30 tons each.

13. Extent of works, about $1\frac{1}{2}$ acres.

TABLE C.—APPROXIMATE STATISTICS OF ENGINEERING MANUFACTURE IN THE NORTH EASTERN DISTRICT.

Number.	Manufacturers. Name.	Manufacturers. Address.	Date of establishment of works.	Description of Work executed.	Total number of hands employed.	Total number of Engines, Boilers, Machines, or Mills completed since the commencement of their works.	Horse-power of said Engines and boilers.	Quantity of raw materials used in the construction of the said Engines and Machinery.	Approximate value of raw materials.
								Tons.	£
1	Hawks, Crawshay, & Co.	Gateshead	1747	Millwork and general machinery, Waterworks, Mill, Colliery, and Marine Steam Engines, Bridges, &c.	1500	92 Marine Engines 58 Land Engines	5000 in 30 years	....	—
2	Murray & Co.	Chester-le-Street	1793	1793 to 1826, Paper, Lead, & Corn Mills, Agricultural Machines and Water Wheels. 1826, engine building and cast iron Foundry. 1841, Boiler Making, underground hauling engines	200	350 Stationary Engines, 500 Boilers, 400 Corn, Clay, Tread, and Lead Mills, Brickmaking Machines, and Waterwheels	15,000 Engines 10,000 Boilers.	15,000	300,000

Number.	Manufacturers. Name.	Manufacturers. Address.	Date of establishment of works.	Description of Work executed.	Total number of hands employed.	Total number of Engines, Boilers, Machines, or Mills completed since the commencement of their works.	Horse-power of said Engines and Boilers.	Quantity of raw materials used in the construction of the said Engines and Machinery.	Approximate value of raw materials.
3	Losh, Wilson, & Bell ...	Walker	1807	Millwork, Steam Engines for Mills, Blast Furnaces, and Colliery purposes	200	250 Stationary Engines & extensive foundry work......	2000	....	—
4	R. and W. Hawthorn ...	Newcastle	1817	Millwork and general Machinery, Waterworks, Mill, Colliery, Marine, and Locomotive Engines	984	797 Locomotive Engines, 121 Mining do., 9 pairs & 2 single Waterwork do., 171 general do., and 80 pairs and 20 single Marine Engines...	15,000, exclusive of Locomotives.	....	—
5	R. Stephenson & Co.* ...	Newcastle	1823	Locomotive, Marine, and Mill Engines, Bridges, &c.	1500	1510 Locomotive Engines, 115 Marine Engines, 206 Marine Boilers, 263 Stationary Engines & Boilers ...	35,000 Engines and Boilers, exclusive of Locomotives.	80,000	2,000,000
6	Marshall & Co.	Willington Quay	1830	Side-lever Paddle Engines for Tug Steamers, and inverted direct acting Engines for Screw Engines ...	300 in Engine Shops, 700 in Boiler Shipyard	600 Engines, with a large proportion of Boilers for the same, chiefly for steamers	3000	....	—
7	Richardson & Sons	Hartlepool	1838	Marine Engines & Machinery connected therewith..	600	340 Steam Engines and Boilers.........	12,318	20,000	300,000
8	Gilkes, Wilson, & Co. ...	Middlesboro'	1841	Millwork and general Machinery, Mill, Colliery, Marine, and Locomotive Engines, Bridges, &c.	1000	100 Locomotive Engines, and a large number of Blowing Engines, Steam Cranes, Marine and Stationary Engines	....	....	—
9	W. G. Armstrong & Co.	Elswick	1847	Millwork and general Machinery, Mill, Waterworks, Locomotive, and Hydraulic Engines, Bridges, &c.	800	202 Locomotive, Stationary, Pumping, and Dredging Engines, 255 Boilers, 173 Hydraulic Engines, 150 Accumulators.........	15,000 Steam Engines, 1100 Hydraulic Engines.	....	1,300,000
10	J. Renoldson	South Shields......	1847	Marine Engines for towing purposes...	40	4 Stationary Engines, 66 Marine Engines for towing purposes	2230	Cast Iron 634, Forged Iron 255, Copper 21, Brass 13, Boiler Plates 726, Bar Iron 396.	—
11	Palmer, Bros., & Co.......	Jarrow	1852	Marine Engines, & Machinery connected therewith	600	71 pairs marine engines, 130 boilers	11,812	Cast Iron 6000, Forged Iron 2500, Boiler Plates 2000, Copper and Brass 350.	150,000
12	Morrison & Co.	Ouseburn	1853	Millwork and general Machinery, Mill, Waterwork, Colliery, & Marine Engines, Steam Hammers, &c. ..	600	80 pairs marine engines, 170 Boilers, 90 Steam Hammers, 30 Land engines, 88 Steam Cranes......	5321	3160, used in the construction of Marine Engines & Boilers.	150,720
13	Thomson & Co............	Newcastle	1850	Millwork and general Machinery, Mill and Marine Engines, &c.	400	26 Land Engines, 7 Dredging Machines, 12 Sugar Mills, 55 pairs Marine Engines, 200 Steam Cranes, 16 Cotton Presses ..	4645	... .	160,000
14	Joy & Co.	Middlesboro'	1862	Steam Engines & Patent Steam Hammers	50	1 Engine, 4 Boilers, 13 Patent Steam Hammers	15 Steam Engines.	....	—

* 38 Wrought Iron Bridges, of various sizes and descriptions.

THE ROYAL SOCIETY.

PRELIMINARY NOTICE OF AN EXAMINATION OF RUBIA MUNJISTA, THE EAST-INDIAN MADDER, OR MUNJEET OF COMMERCE.

By John Stenhouse, LL.D., F.R.S.

It is rather remarkable that while few vegetable substances have been so frequently and carefully examined by some of the most eminent chemists than the root of the *Rubia tinctorum*, or ordinary madder, the *Rubia munjista*, or munjeet, which is so extensively cultivated in India and employed as a dye-stuff, has been, comparatively speaking, very much overlooked, never having been subjected, apparently, to anything but a very cursory examination. Professor Runge, at the close of his very elaborate memoir upon madder, published in 1835, details a few experiments which he made upon the tinctorial power of munjeet, the constituents of which he regarded as very similar to those of ordinary madder. Professor Runge stated that munjeet contains twice as much available colouring matter as the best Avignon madder. This result was so unexpected that the Prussian Society for the Encouragement of Manufactures, to whom Professor Runge's memoir was originally addressed, referred the matter to three eminent German dyers, Messrs. Dannenberger, Böhm, and Nobiling. These gentlemen reported, as the result of numerous carefully conducted experiments, that, so far from munjeet being richer in colouring matter than ordinary madder, it contained only half the quantity. This conclusion has been abundantly confirmed by the experience of my friend Mr. John Thom, of Birckacre, near Chorley, one of the most skilful of the Lancashire printers. From some incidental notices of munjeet in Persoz and similar writers, and a few experiments which I made some years ago, I was led to suspect that the colouring matters in munjeet, though similar, are by no means identical with those of ordinary madder, and that probably the alizarine or purpurine of madder would be found to be replaced by some corresponding colouring principle. This hypothesis I have found to be essentially correct; for the colouring matter of munjeet, instead of consisting of a mixture of alizarine and purpurine, contains no alizarine at all, but purpurine and a beautiful orange colouring matter crystallising in golden scales, to which I purpose giving the name of "munjistine." Munjistine exists in munjeet in considerable quantity, and can therefore be easily obtained.

The colouring matter of munjeet may be extracted in various ways; that which I have found most suitable is as follows:—Each pound of munjeet in fine powder is boiled for four or five hours with two pounds of sulphate of alumina and about sixteen of water. The whole of the colouring matter is not extracted by a single treatment with sulphate of alumina; the operation must be repeated therefore two or three times. The red liquid thus obtained is strained through cloth filters while still very hot, and the clear liquor acidulated with hydrochloric acid. It soon begins to deposit a bright red precipitate, the quantity of which increases on standing, which it should be allowed to do for about twelve hours. This precipitate is collected on cloth filters and washed with cold water till the greater portion of the acid is removed. It is then dried, reduced to fine powder, and digested in a suitable extracting apparatus with boiling bisulphide of carbon, which dissolves out the crystallisable colouring principles of the munjeet, and leaves a considerable quantity of dark-coloured resinous matter. The excess of the bisulphide of carbon having been removed by distillation, the bright red extract, consisting chiefly of a mixture of munjistine and purpurine, is treated repeatedly with moderate quantities of boiling water and filtered. The munjistine dissolves, forming a clear yellow liquid, while almost the whole of the purpurine remains on the filter. When this solution is acidulated with hydrochloric or sulphuric acid, the munjistine precipitates in large yellow flocks. These are collected on a filter and washed slightly with cold water. The precipitate is then dried by pressure, and dissolved in boiling spirit of wine slightly acidulated with hydrochloric acid to remove any adhering alumina. As the munjistine does not subside from cold alcoholic solutions, even when they are largely diluted with water, about three-fourths of the spirit are drawn off by distillation, when the munjistine is deposited in large yellow scales. By two or three crystallisations out of spirit in the way just described the munjistine is rendered perfectly pure.

I have likewise succeeded in extracting munjistine directly from munjeet by boiling it with water, filtering the solution, which has a dark brownish-red colour, and then acidulating with hydrochloric acid. The precipitate which falls is collected on a filter, washed, dried, and treated with boiling spirit of wine, which leaves a large quantity of pectine undissolved. The munjistine which dissolves in the alcohol is obtained in a pure state by repeated crystallisations in the way already indicated. The first process which I have described is, however, by far the best. The colouring matter of munjeet can likewise be extracted with boiling solutions of alum; but I find sulphate of alumina greatly preferable, as the alum, by its tendency to crystallise, very much impedes the filtration of the liquids. I likewise attempted to employ Professor E. Kopp's process with sulphurous acid, which gives such excellent results with ordinary madder, but I found it wholly inapplicable to munjeet.

Munjistine, prepared by the processes described, when crystallised out of alcohol, forms golden-yellow plates of great brilliancy. It is but moderately soluble in cold, but dissolves pretty readily in boiling water, forming a bright yellow solution, from which it is deposited in flocks when the liquid cools. Saturated solutions almost gelatinise. It dissolves to some extent in cold, but more readily in boiling spirit of wine, and is not precipitated by the addition of water. It dissolves in carbonate of soda with a bright red colour. In ammonia it forms a red solution with a slight tinge of brown; caustic soda produces with it a rich crimson colour. Both its aqueous and alcoholic solutions, when boiled with alumina, form beautiful flakes of a bright orange colour, almost the whole of the munjistine being withdrawn from solution. These flakes are soluble in a large excess of caustic soda, with a fine crimson colour. Munjistine dyes cloth mordanted with alumina a bright orange. With iron mordant it yields a brownish-purple colour, and with Turkey-red mordant a pleasing deep orange. These colours are moderately permanent, and bear the application of bran and soap tolerably well. The munjistine sensibly modifies the colours produced by munjeet, giving the reds a shade of scarlet, as has been long observed.

Commercial nitric acid dissolves munjistine with a yellow colour, but does not appear to decompose it even on boiling. Fuming nitric acid (1·5) dissolves munjistine in the cold, and on application of heat decomposes it, no oxalic acid being produced. It readily dissolves in cold sulphuric acid with a bright orange colour; and the solution may be heated nearly to boiling without blackening or giving off sulphurous acid; it is reprecipitated by water in yellow flocks apparently unaltered. When bromine water is added to a strong aqueous solution of munjistine, a pale coloured flocculent precipitate is immediately produced; this when collected on a filter, washed and dissolved in hot spirit, furnishes minute tufts of crystals, evidently a substitution product. I may remark, in passing, that when alizarine is treated with bromine water in a similar way, it also forms a substitution product crystallising in needles. I am at present engaged in the examination of both these compounds.

When munjistine is strongly heated on platinum foil, it readily inflames and leaves no residue; when it is carefully heated in a tube, it fuses, and crystallises again on cooling. It sublimes more readily than either purpurine or alizarine, forming golden scales which consist apparently of unaltered munjistine, as they give the characteristic rich crimson colouration with caustic alkalies. Baryta water produces a yellow precipitate with munjistine. Acetate of lead throws down a bright crimson precipitate, both in its aqueous and alcoholic solutions. I expect, from this and the bromine substitution compound, very shortly to ascertain the atomic weight of this body; in the mean time I submit the results of its ultimate analysis.

I. ·314 grm. of munjistine yielded ·732 grm. of carbonic acid and ·106 grm. of water.

II. ·228 grm. munjistine yielded ·535 grm. carbonic acid and ·0765 grm. water.

		I.	II.
C	per cent.	63·6	64·0
H	„	3·77	3·73
O	„	32·63	32·27
		100·00	100·00

The munjistine operated upon in each case was prepared at different times; moreover, No. 1 was burnt with oxide of copper, No. 2 with chromate of lead.

Munjistine in some of its properties bears considerable resemblance to Runge's madder-orange, the "rubiacine" of Dr. Schunck; it is, however, essentially different from rubiacine, both in several of its properties, such as its solubility in water and alcohol, &c., and in the amount of its carbon—rubiacine, according to Dr. Schunck's analysis, containing 67·01 per cent. of that element, while munjistine contains only 64. The spectra afforded by solutions of the two substances, as may be seen from the following extract from a letter received from Professor Stokes, are decidedly different:—

"The two substances are perfectly distinguished by the very different colour of their solution in carbonate of soda, when a small quantity only of substance is used. The solution of munjistine is red inclining to pinkish orange, that of rubiacine a claret-red. The tints are totally different, and indicate a different mode of absorption. Both present a single minimum in the spectrum; but while that of rubiacine extends from about D to F, that of munjistine extends from a good way beyond D to some way beyond F. The beginning and end of the band in each case is not very definite, and varies of course with the strength of the solution; but by comparing the substances with different strengths of solution, there can be no doubt of the radical difference in the position o

the band of absorption. In this way it is easy to convince oneself that the difference of colour is not to be explained by the possible admixture of some small impurity present in one or other specimen. With caustic potash munjistine gives as nearly as possible the same colour as rubiacine, agreeing with the colour of rubiacine in carbonate of soda. There appears to be a slight difference in the spectrum of the munjistine and rubiacine solutions, but not enough to rely on; so that the substances are not to be distinguished by their solutions in *caustic* alkalies.

"A second perfectly valid distinction is, however, afforded by the different colour of the fluorescent light of the ethereal solutions. The solid substances themselves and their ethereal solutions are fluorescent to a considerable degree; but the tint of the fluorescent light of the ethereal solution of rubiacine is orange-yellow, while that of the ethereal solution of munjistine is yellow inclining to green. The examination in a pure spectrum shows that the difference is not due to the admixture of a small impurity, itself yielding a fluorescent solution; but the tints may be readily contrasted by daylight, almost without apparatus, by the method I have described in a paper 'On the existence of a second crystallisable fluorescent substance in the bark of the horse-chesnut.' (*Quarterly Journal of the Chemical Society*, vol. ii. p. 20). I consider either of the two points of difference I have mentioned sufficient by itself to establish the non-identity of munjistine and rubiacine."*

The purpurine which I succeeded in extracting from munjeet, and in purifying from munjistine in the way already described, formed beautiful dark crimson needles, having all the usual properties of that substance. When examined by Professor Stokes, they gave the very characteristic spectra of purpurine.

·3285 grm. of purpurine gave ·8005 grm. carbonic acid and ·1050 grm. water.

	Analysis.		
	Theory.	Found.	Debus (mean).
C....................	66·67	66·46	66·40
H....................	3·70	3·55	3·86
O....................	29·63	29·99	29·74
	100·00	100·00	100·00

From the results above detailed there can therefore be no doubt that the colouring matter of munjeet, as already stated, consists of purpurine and munjistine.

I cannot conclude this preliminary notice without acknowledging the essential services I have received from Professor Stokes, who kindly submitted the different products obtained by me to optical examination. Though it is plain that a substance optically pure, that is, containing no impurities affecting the spectrum, may still be far from being chemically so, yet the spectroscope is extremely useful in indicating admixtures of kindred substances of very similar properties, having a great affinity for each other, and therefore not readily separable. I feel certain, therefore, that if Professor Stokes would draw up a short treatise, embodying his extensive and accurate observations on the spectra of the colouring matters and similar substances, he would confer a great boon on the cultivators of organic chemistry.

Since the preceding paper was communicated to the Royal Society, I have been enabled to examine the action of nitric acid on munjistine much more fully. When munjustine is digested with moderately strong nitric acid, as already stated, copious fumes are given off, the munjistine gradually dissolving and forming a colourless solution. When this is evaporated to dryness on the water-bath, a white crystalline mass is obtained, consisting almost entirely of phthalic acid contaminated with a small quantity only of oxalic acid. The oxalic acid may be easily removed by washing the mass with a little cold water and then pressing between folds of bibulous paper, or by neutralising the mixture of the two acids with lime and then treating with boiling water, which dissolve the phthalate of lime. The acid freed from oxalic acid by either of these methods presents all the usual reactions of phthalic acid. One of the most convenient ways of purifying it consists in subliming it repeatedly in a Mohr's apparatus, when the anhydrous acid is obtained in beautifully white iridescent four-sided prisms, frequently several inches in length. ·3745 grm. of the crystals of the anhydride, burnt with chromate of lead, gave ·891 grm. carbonic acid and ·096 grm. of water.

	Theory.	Expt.	Marignac.	Laurent.
C_{16} 96	64·86	64·89	64·88	64·70
H_4 4	2·70	2·81	2·71	2·38
O_6 48	32·44	32·30	32·41	32·92

From this result it is evident that the acid chiefly produced by the actions of nitric acid upon munjistine is phthalic acid, which, as is well known, may also be procured from alizarine and purpurine. This reaction, therefore, indicates a very close relationship between these three substances, the only true colouring principles of madder with which we are at present acquainted.

* I may mention that the rubiacine which Professor Stokes examined was prepared by Dr. Schunck himself.

THE CHEMICAL SOCIETY.

NOTE ON SOME METAMORPHOSES OF OXALIC ACID.

By ARTHUR H. CHURCH, B.A.

When oxalate of sodium is submitted to the action of sodium-amalgam in presence of water, some interesting effects ensue. If the action be not accelerated by elevation of temperature, and the amount of salt employed be large, a partial reduction only of the oxalic acid takes place, in accordance with the equation—

$$\underset{\text{Oxalic acid.}}{C_2H_2O_4} + H_2 = \underset{\text{Glyoxylic acid.}}{C_2H_4O_4}$$

A more ready method of attaining the same result is found in the reaction of zinc, oxalate of zinc, and sulphuric acid. A large quantity of oxalate of zinc is placed, together with a few pieces of pure zinc, in a beaker, the mixture covered with water, and dilute sulphuric acid added very slowly, drop by drop. Milk of lime, in very slight excess, having been added, together with much water, and the mixture warmed, the whole was filtered, saturated with carbonic acid, again warmed, and filtered. The filtrate deposited, on cooling, some quantity of fine needle-shaped crystals of glyoxylate of calcium. This salt required about 160 parts of cold water for solution. Calcium and water determinations suggested for this salt the formula—

$$C_2HCaO_3.H_2O,$$

while a series of careful qualitative experiments proved the identity of the acid of which it was the calcium compound with Debus's glyoxylic acid. A larger yield of this product is obtained if, in the process just given, the use of lime be altogether omitted, the glyoxylic acid being extracted directly by means of ether from the concentrated and acidified solution of the mixed zinc-salts first formed. The syrupy etherial solution is treated with carbonate of calcium, and the various calcium-salts thus made are separated by the method of Debus.

When lime-water was added to the solution of the glyoxylate, a white powder fell, agreeing in its amount of calcium with the formula—

$$C_2Ca_2O_3,$$

and suffering, when boiled for some time with water, the following change—

$$\underset{\text{Glyoxylic acid.}}{2C_2H_2O_3} + H_2O = \underset{\text{Oxalic acid.}}{C_2H_2O_4} + \underset{\text{Glycollic acid.}}{C_2H_4O_3}.$$

This transformation of oxalic acid into glycollic acid has, however, been previously accomplished. Under the name of *ozonic* acid, F. Schulze has described one of the products obtained by acting upon oxalic acid with zinc in presence of sulphuric acid. Schulze, indeed, in all probability, thus obtained glyoxylic acid; but his method of eliminating the new product of the reaction, by ebullition of the zinc salts with excess of milk of lime, necessarily destroyed the glyoxylate first formed, producing oxalate and glycollate, as stated above. But if we adopt Schulze's plan, and instead of moderating in every way the reducing action in the experiment under review, we exalt its energy in every way, then glycollic acid is the chief product. The method of procedure in this case may be thus modified:—Into a retort containing a large quantity of zinc and dilute sulphuric acid, and heated by a lamp, small quantities of oxalic acid are introduced from time to time. When the desired quantity of acid has been added, a brisk evolution of hydrogen is maintained for some hours, and the liquid boiled with excess of zinc till the acids present are saturated. Excess of slaked lime having been added to the mixed salts, the whole is to be saturated with carbonic acid, boiled, and filtered. This filtrate, on concentration, deposits abundance of glycollate of calcium, in concentric tufts of fine crystals. Analysis and qualitative experiments confirmed the identity of the formula of this salt—

$$C_2H_3CaO_3 + aq.$$

But in the mother liquor from which the glycollate had been deposited, another calcium-salt was contained. This salt was excessively soluble in water, thus differing from the oxalate, the glyoxylate, and the glycollate of calcium. When to its warm syrupy solution an exactly equivalent quantity of sulphuric acid was added, and the sulphate of calcium separated, star-shaped clusters of crystals filled the filtrate. Further examination proved these crystals to be an acid. As far as the small quantity of this substance at my disposal permitted, I have determined some of its properties and its probable composition.

This acid is soluble in water, and readily crystallisable. From its boiling aqueous solution, it evaporates slowly, with a peculiar faint odour. It melts above 100° C. Its lime salt (the only one yet made) is very soluble in cold water, and confusedly crystalline. A combustion of this acid dried over sulphuric acid indicated the formula—

$$C_2H_4O_2;$$

while a calcium determination in the salt of that metal gave numbers nearly agreeing with the formula

$$C_2H_3CaO_2 + aq.$$

If the preliminary examination of these substances has conducted me to a correct conclusion, and I am right in supposing the last-mentioned acid to have the formula assigned to it, we have a new isomer of acetic acid, differing remark-

ably from that body in several particulars. The series of reduction-products of oxalic acid will stand thus:—

Oxalic acid	$= C_2H_2O_4$, which $-$ O gives
Glyoxylic acid	$= C_2H_2O_3$, which $+$ H_2 gives
Glycollic acid	$= C_2H_4O_3$, which $-$ O gives
New acid	$C_2H_4O_2$.

By addition of H_2 to the last term, glycol, $C_2H_6O_2$, might perhaps be formed.

The existence of a body $C_2H_4O_2$ has, I find, been predicted by Professor Kekulé. He gives the following table (*Lehrbuch der Organischen Chemie*, Bd. ii, s. 18)—

Monatomic series:—

C_2H_6O Alcohol.	$C_2H_4O_2$ Acetic acid.	C_2H_4O Aldehyde.

Biatomic series:—

$C_2H_6O_2$ Glycol.	$C_2H_4O_3$ Glycollic acid.	$C_2H_2O_4$ Oxalic acid.
$C_2H_4O_2$ (Unknown.)	$C_2H_2O_3$ Glyoxylic acid.	$C_2H_2O_2$ Glyoxal.

It is thus clearly shown how a monatomic alcohol, losing H_2, yields one aldehyde, and this, gaining O, yields one acid; while, on the other hand, a triatomic alcohol, by losing H_2 or $2H_2$ yields two aldehydes, and each of these, by gaining O, yields another acid. The new acid may thus be the missing first aldehyde of glycol, of which glyoxylic acid may be regarded as the second.

It will not be unreasonable to expect corresponding results from the action of nascent hydrogen on the homologues and analogues of oxalic acid, and the acid and neutral ethers* of these acids.

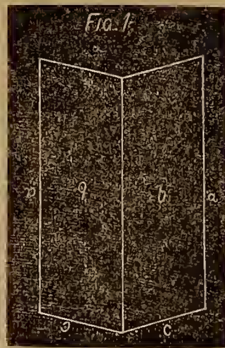
I have commenced a few experiments in this direction also.

Succinic acid, after the prolonged and energetic action of nascent hydrogen, as above described in the case of oxalic acid, suffers a similar change. I have not endeavoured to moderate the action so as to form the intermediate or butyloxylic acid, but have pushed it to the extreme, so that butylactic acid might be obtained.

The operation was performed in a retort; towards its conclusion a powerful odour, resembling that of butyric acid, was noticed in the aqueous distillate. The mixture of zinc-salts in the retort was evaporated, sulphuric acid added in excess, and the liquid shaken up with ether. From this ethereal solution (besides some unchanged succinic acid) a deliquescent acid was obtained, the properties and salts of which agreed completely with those of the butylactic acid of Wurtz. I have likewise submitted suberic and phthalic acids to the above-described treatment, and the reactions promise interesting results. But the products of these reactions, obtained only very recently await further purification and analysis; and it would be altogether premature to express any opinion as to their composition.

DR. JOHN STENHOUSE, F.R.S., ON LARIXINIC ACID, A CRYSTALLISABLE PRINCIPLE FOUND IN THE BARK OF THE LARCH TREE (PINUS LARIX, *Linn.*)†

The most convenient way of preparing this somewhat singular substance consists in cutting the bark of the larch into small pieces, and then digesting it in water for twenty-four hours at a temperature of about 80° C. The solution, which has a deep reddish-brown colour, is then poured off on to a second portion of larch bark and digested as before. The concentrated infusion is then cautiously heated in an open porcelain dish, at the temperature of about 80° C., till it is converted into a syrup. A portion of this syrup is then distilled, either in glass or porcelain retorts, or, what is better than either, in a silver alembic. Iron retorts cannot be employed for this purpose, as the acetic acid which is always produced during distillation, by forming acetate of iron, instantly destroys the larixinic acid, changing it into a deep purple-coloured liquid. When a silver alembic cannot be procured, a very convenient way of distilling the extract of the larch is to pour it into a large Florence flask, the neck of which is passed obliquely through a cork or bung, inserted into a glass condenser. When the flask is cautiously heated on a sand-bath, the larixinic acid comes over with the first portions of the liquid, but becomes more abundant as the distillation proceeds, and usually forms large flat crystals which condense on the sides and neck of the receiver. The liquid which is distilled over, and which contains the greater portion of the larixinic acid, should be poured into small flat basins, and cautiously concentrated at about 60° C. When the greater portion of the water has been dissipated, it is advisable, especially in warm weather, to complete the operation by spontaneous evaporation; for unless the concentration of the aqueous solution of larixinic acid is conducted cautiously, the larixinic acid volatilises along with the vapour of water, and is thereby lost. The highly concentrated solution of larixinic acid obtained in the way just described, deposits, on standing, brownish-yellow crystals, which are impure larixinic acid. This is to be pressed between folds of blotting-paper, and re-crystallised from a small quantity of water. The larixinic acid may be rendered perfectly pure by subliming it once or twice. This is easily effected by placing the larixinic acid between two watch-glasses, or in any other suitable apparatus, and heating it cautiously on a sand-bath, or even on a water-bath, as it sublimes at the very low temperature of 93° C. The larixinic acid is a proximate principle, which exists ready formed in the larch. This is easily proved by distilling even a dilute infusion of the bark, when the liquid which passes over will be found to strike a deep purple colour with a persalt of iron, which is very persistent. The bark of old larch trees contains very little larixinic acid; but the bark of the small branches, and that of the stems of the larch, when not more than from twenty to thirty years of age, contains very considerable quantities of this substance, the concentrated syrup from the portions of bark yielding more larixinic acid than an equal weight of catechu does of oxyphenic acid. Larixinic acid, after it has been purified by sublimation, forms beautifully white crystals, often more than an inch in length, of a brilliant silvery lustre, very much resembling benzoic acid in appearance. They sublime at 93° C., and melt at 153° C., but the aqueous solutions volatilise at ordinary temperatures. I am indebted to the kindness of Professor W. H. Miller, of Cambridge, for the subjoined measurements of the crystals of larixinic acid.



"The crystals obtained by sublimation become rough so rapidly when exposed to the air, that very little confidence can be placed in the following results:—

"The crystals belong to the oblique system; they usuall occur in twins, like the annexed figure. They are extremely thin in a direction perpendicular to *b*. Denoting by *l*, *m*, *n* faces in the zone *a b*, and by *r* a face in the zone *b c*, it appears that tan *b l*, tan *b m*, tan *b n* are nearly as the numbers 2, 3, 6, and that *a b* = 90° 0′, *b c* = 90° 0′, *a c* = 76° 0′, *b l* = 49° 29′, *b m* = 60° 20′, *b n* = 74° 6′, *b r* = 75° 30′. Cleavage *a* distinct, *c* imperfect.

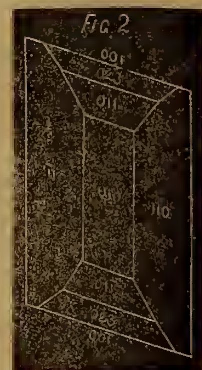
"The crystals of larixinic acid crystallised from water are very imperfect; the angles must be regarded as very rough approximations. They are deduced, as well as I could deduce them, from a mean of a considerable number of observations by no means agreeing with each other. The angle between the normals to two faces is taken as the measure of the angle between the faces.

"Oblique:—

1 0 0, 1 0 1 = 26° 22′
0 1 0, 1 1 1 = 74° 36′; 0 0 1, 1 0 1 = 44° 20′.

"Forms observed:—

0 1 0, 0 0 1. 1 1 0, 0 1 1, 0 2 3.



Angles.
1 1 0, 0 0 1 = 71° 58′
1 0 1, 1 1 0 = 69° 35′
0 1 0, 0 1 1 = 59° 37′
0 1 0, 0 2 3 = 68° 39′
0 1 0, 0 0 1 = 90° 0

"Cleavage 0 0 1 distinct, and very easily obtained."

The smell of the aqeous solution of larixinic acid is sweetish, like that of a syrup, but the smell of the sublimed acid is very peculiar and slightly empyreumatic. As larixinic acid emits a sensible odour at ordinary temperatures, it bears in this respect a considerable resemblance to napthaline and ordinary camphor. The taste of larixinic acid is slightly bitter and astringent. It reddens litmus paper very slightly, but a single drop of potash or ammonia, when added to a solution of a large quantity of larixinic acid, renders it alkaline. Larixinic acid is very soluble in boiling water, but by no means very soluble in cold water, 87·88 parts of water at 15° C. dissolving 1 part of the acid only; but the solubility of larixinic acid in cold aqueous solutions is greatly increased by the addition of either acids or alkalies. Larixinic acid is deposited from its aqueous solutions in crystals which are very brittle, and often an inch or two in length. It likewise dissolves in cold alcohol, but to a much greater extent in hot alcohol. The crystals deposited from its alcoholic solutions are thicker and more distinctly formed than those from water. It also dissolves but sparingly in ether, and is deposited in crystals of very considerable lustre.* The following are the results of the analysis of the larixinic acid:—

Calculated numbers.			Found. I.	II.	III.
C_{20}	=	57·14	57·13	57·06	57·09
H_{10}	=	4·77	5·04	5·09	5·04
O_{10}	=	38·09	37·83	37·85	37·87

From these results it is evident that the carbon, hydrogen, and oxygen in larixinic acid are in the proportion of $C_2H_1O_1$, or some multiple of these numbers, $C_{20}H_{10}O_{10}$ being the numbers we have adopted as the more probable.

When a quantity of larixinic acid was dissolved in a great excess of liquid ammonia, a yellow-coloured solution was produced; when this was evaporated to dryness, over sulphuric acid *in vacuo*, the larixinic acid was deposited in crystals which were nearly unaltered. It gave its characteristic reactions with salts of iron, and when boiled with milk of lime gave off no trace of ammonia. The combination which larixinic acid forms with ammonia is, therefore, so feeble that it is decomposed by the volatility of the ammonia. In this respect, therefore, and in its forming no hydrate, larixinic acid closely resembles both pyrogallic and oxyphenic acids.

When larixinic acid was treated with an excess of aqua potassæ it very readily dissolved, forming a yellowish solution. When dried over sulphuric acid *in vacuo*, the potash combination formed long flattish crystals having considerable lustre, but of a reddish-brown colour. These crystals, when pressed between

* From oxalate of ethyl, M. Löwig has already obtained in this way paratartaric acid.
† From the Philosophical Transactions, 1863.

* The crystals of larixinic acid catch fire readily, and burn with a bright flame, leaving no residue.

folds of blotting-paper to free them from excess of potash, and re-crystallised *in vacuo*, yielded crystals which were more deeply coloured than the first. This potash combination is so very feeble that it is decomposed by carbonic acid. It contained a considerable quantity of potash; but I have not been able to obtain it of a constant composition.

A solution of larixinic acid gives no precipitate, either with lime-water or with saccharate of lime. The behaviour of larixinic acid with baryta is extremely singular and characteristic. When a solution of caustic baryta is added to a concentrated aqueous solution of larixinic acid, the latter being in excess, a bulky semi-transparent, gelatinous precipitate immediately falls, and if the solutions are concentrated, fills the whole vessel. This precipitate, which considerably resembles hydrated alumina, is but slightly soluble in cold water; but it dissolves very readily in boiling water, from which it is again deposited on the cooling of the liquid. This baryta-compound is readily decomposed by carbonic acid. When thrown on a filter and washed, the air being carefully excluded, it was dried *in vacuo* over sulphuric acid, and was then found to contain, as the mean of two experiments, 34·92 per cent. of baryta.

A solution of larixinic acid yields no precipitate with either basic or neutral acetate of lead, neither is it precipitated by nitrate or ammonio-nitrate of silver; but when its solution in the latter salt is boiled, the silver is reduced in a pulverulent state. Larixinic acid forms no precipitate with perchloride of platinum, even on the application of heat. It does not contain any nitrogen. It does not reduce oxide of copper when tried by Trommer's test. It dissolves in concentrated sulphuric acid, but no conjugate combination is produced, as was ascertained by neutralising with carbonate of baryta, larixinic acid being obtained unchanged. When larixinic acid is boiled with a mixture of hydrochloric acid and chlorate of potassa, it is decomposed, but without the formation of chloranile. When it is boiled with a solution of hypochlorite of lime, no colouration is produced. It is readily attacked by nitric acid, especially when assisted by heat; nitrous fumes are given off, and oxalic acid is the only fixed product, and is also readily attacked by bromine, especially when assisted by heat. Abundant vapours of hydrobromic acid are given off, the larixinic acid being entirely destroyed and converted into an uncrystallisable resin. The salts of copper produce an emerald green colour in solutions of larixinic acid, but no precipitate. Chloride of manganese produces neither colouration nor precipitation. Protosulphate of iron strikes a brownish-red colour with solutions of larixinic acid, which acquire a brighter red colour on standing, resembling meconate of iron. Perchloride and persulphate of iron produce a beautiful purple dahlia colour, which is very persistent, and stands dilution well. Its reactions with salts of iron are very characteristic of larixinic acid, which forms an excellent reagent for the detection of salts of iron, even in very minute quantities. In this way the presence of iron in tolerably pure sulphate of copper can readily be detected by the purple colouration produced. Larixinic acid does not affect neutral protonitrate of mercury in the cold; and on the application of heat no mercury is reduced.

Larixinic acid appears to be peculiar to the larch tree; at least I have not been able to find a trace of it in the bark of the spruce fir (*Abies excelsa*), or in that of the Scotch fir (*Pinus sylvestris*). Larixinic acid evidently belongs to that small group of substances of which pyrogallic acid and pyrocatechin, the oxyphenic acid of Gerhardt, are the only other members yet known. Larixinic acid is much less easily oxydisable than oxyphenic acid, which again is less easily oxidated than pyrogallic acid. Larixinic acid volatilises at a much lower temperature than either of these two substances, from which it also differs in being a ready-formed proximate principle, and not an educt.

Addendum.—In consequence of the extremely feeble, if not somewhat doubtful, acid properties of the so-called larixinic acid, perhaps the name *Larixin* would be more appropriate; but in that case the name of pyrogallic acid should be altered to *pyrogallin*, and that of oxyphenic acid to *pyrocatechin*, the name originally given to it by Zwenger.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.

At a monthly meeting of this society, held on the 5th ult., Mr. Joseph Newton, President, in the chair, the auditors for the half-year just expired presented their report, which showed that, in a numerical and financial sense, the association was in a prosperous condition.

Mr. Gettliffe then read his promised Paper on "An Apparatus for the Prevention of Steam Boiler Explosions and Railway Accidents;" and, after some preliminary observations, proceeded to say that the apparatus was the invention of M. Auguste Acharde, C.E., of Paris, and that it was known in France under the title of the "Embrayage Electrique." It was calculated to maintain a constant level feed in steam boilers by automatic means, and without the assistance or supervision of the engineman. This regulator, as it might be termed, consisted of a ratchet wheel of peculiar construction, and which was keyed upon a spindle turning freely in its bearings. Right and left of the wheel were mounted loosely on the spindle two wrought iron levers of about 20in. each in length, and connected together by cross-pieces. A two-armed "click," supported by the levers, turned freely round an axis. The double click acted upon the ratchet wheel, which was furnished with two sets of teeth turned in opposite directions to each other and separated by a blank space. The click was fitted with a tail-piece in the form of a fork, the two prongs of which were braced together by a cross-rod. In the fork was mounted an "armature," which was provided with an opening through which passed the cross-piece. The armature was made of brass, and to it was attached a piece of soft iron fitted in so as to be flush with the surface of the armature. Opposite to this latter was placed a horizontal electro-magnet, the poles of which abutted against the armature in such a way as that it (the armature) could only slide against the poles without coming into immediate contact therewith. The part placed by the armature was merely to act as a weight on the levers supporting the fork; for it would be understood that when the electric current was in circulation, the armature would be suspended by its adherence to the electro-magnet, and thus relieve the fork of its weight. The suspension of the current, on the contrary, would cause it to drop on the cross-piece connecting the levers, and thus alter the gravity of the fork. It was those alterations of the weight on the tail-piece of the levers which caused the fork to act upon the upper or lower set of teeth on the ratchet wheel; or, in other words, to open or shut the feed-cock of the boiler. It was necessary that the fork should have continual motion—a kind of pump-handle movement, indeed—which could be effected by a simple contrivance (a small eccentric, for instance, attached to a running shaft on the general machinery). The effect would be that the compound ratchet wheel would be acted upon and moved in one direction when the boiler required feeding, and in the other when fed sufficiently. If all were going on well, the click would simply move over the blank portion of the wheel, and communicate no motion whatever to it. Advancing now to the general action of the contrivance, the reader proceeded to state that when the current was broken off from the electro-magnet, the weight of the armature operating upon the cross-piece would press down the tail-piece of the levers carrying the click, which latter would rise and act with its lower arm upon the ratchet wheel. The consequence would be, that the wheel would turn from left to right to the extent of one tooth, or about half an inch at each oscillation of the levers, until the blank space presented itself and stopped further movement. This would be at a point when the wheel had made one-fourth of a revolution. On the other hand, when the current was in circulation, the armature, in sliding against the poles of the electro-magnet, would bring the plate of soft iron into contact with the poles, which would then hold it firmly, and prevent the armature descending with the click during the downward oscillation of the levers. The tail-piece would thus be relieved, and not have to support any weight while the latter rocked in the opposite direction. It would follow that the upper arm would then act upon the wheel, and cause it to turn the reverse way, *i.e.*, from right to left. It would thus become evident that the two-armed click would act on the ratchet wheel, and cause it to move in opposite directions, whether the electric current were traversing the electro-magnet or not. The rising and falling of the float in the boilers of stationary or land engines controls the electric current, and causes it to circulate or be interrupted at the proper times. This result is obtained directly by the wires which proceed from the pile or battery being made to pass first to the float instead of being connected immediately to the electro-magnet. The float itself was connected by a rod with an index, on the lever of which was mounted a piece of wood faced on one side with a brass plate. On another piece of wood, in the form of a rocking lever, and moving on an axis, was a second plate of brass. The electric wire from one of the poles of the battery was fixed to the first-named plate, and the other end of the wire, after traversing the electro-magnet, was attached to the other pole of the battery. In order that the current might circulate, it was indispensable that both plates should meet, and from the peculiar arrangement of the two metallic plates, they would always be in contact when the index was at zero (the normal feeding point) or above it, but the contact ceased as soon as the index fell below zero. Let it be supposed that the feed-cock of the force-pump, or other appliance for supplying water to the boiler, was connected to the spindle of the ratchet-wheel: it would follow that the cock must partake of the movement of the wheel, and that it will make a quarter of a turn in one direction when the electric current circulated, and a quarter of a turn in the other when the current was interrupted: thus the automaton regulator, which was sensitive to the smallest alteration in the water level of the boiler, was perpetually and inevitably maintaining it at a constant height, and thus one great source of danger was obviated. As an extra security, however, against accident by explosion, a minor contrivance was affixed to the same apparatus, and which owed its action to similar principles. On the side of one of the levers was fastened a cap with a gudgeon in its centre. An armature resembling that already described was carried by this cap and rested on the gudgeon. In connection with this second armature was placed an electro-magnet, against which it was made to slide and press constantly upon the poles. It was still the index of the water gauge, which induced the circulation or effected the interruption of the electric current; and the same electric pile or battery, composed of a single element, or Daniel's pair, sufficed to put in motion the two electro-magnets. The electric wire which proceeded from one of the poles of the battery, and was affixed to the brass plate on the lever at the index, served for the two electro-magnets also. The returning wire corresponding with that about to be described, however, was fixed to a third brass plate, and, after traversing the electro-magnet was attached to the second pole of the battery. The last-mentioned plate was arranged in such a manner as to establish a metallic contact which permitted the electric current to pass, notwithstanding the variation in the level of the water to the extent of an inch above or below its proper line. If the variation exceeded these limits, the current would be forcibly broken. When the electric current was in circulation—that is to say, when the lever was between the limits of variation named—the armature would be suspended by the adhesion of the second electro-magnet; but if the level rose or fell beyond those points, the armature, from the current being broken, must fall. In either case, a small tappet fixed to the armature below the gudgeon touches an alarm lever and thus rings a bell. This arrangement is also serviceable in other respects. The alarm bell rings when the feed-pump is out of order; when the electric pile ceases to act; if the stoker neglects the fire; or if steam is generated too rapidly. The reader proceeded to point out the application of the "Embrayage Electrique" to the prevention of railway accidents by connecting it with brakes upon the wheels of the engines and carriages, and certainly gave some very practical illustrations of its value and efficacy in this respect. In France it is extensively used and testimonials in its favour from many eminent scientific men were, together with the apparatus, submitted to the meeting. It was also stated that the apparatus might be seen daily in action at the works of Mr. Cater, engineer, &c., Grove, Southwark; also at Messrs. Simpson's, Little Britain, City.

VISIT OF THE INSTITUTION OF MECHANICAL ENGINEERS TO CREWE.

In connection with the annual meeting of the Institution of Mechanical Engineers, held this year at Liverpool, a series of visits have been paid to several engineering establishments, or other places of interest in the neighbourhood; amongst others, the large engine works belonging to the London and North-Western Railway Company, at Crewe, were, on the invitation of Mr. John Ramsbottom, the locomotive superintendent of the line, visited by about one hundred and fifty of the members, on Friday, the 7th of August last. They were conveyed by a special train, kindly placed at their disposal by the directors of the line, from the Lime-street Station in the first place, to Parkside, about seventeen miles from Liverpool, to examine Mr. Ramsbottom's patent apparatus, which has been laid down near that station, for supplying with water the tenders of locomotive engines whilst in motion. It will be remembered that a working model of this apparatus was exhibited in the International Exhibition of last year, where it attracted considerable attention. A Plate Illustration and detailed description of the apparatus having already appeared in The Artizan (July, 1863), it will only be necessary here to remind our readers that it consists of a dip pipe or scoop attached to the bottom of the tender, with its lower end curved forward, and dipping into the water, contained in an open trough lying longitudinally between the lines of rails, at about the rail level, so as to scoop the water, and deliver it into the tender tank while running. On the arrival of the train at Parkside, the engine, which was fitted with the dip pipe and gearing, was run several times over the trough, in order that the members might, either on the tender or on the line, witness the apparatus in action.

From Parkside the train proceeded to Crewe, arriving there about noon. These works consist principally of a rolling mill for the manufacture of permanent way rails, and engine works for the manufacture and repair of the locomotive stock of the line. The latter, first opened in the year 1843, in connection with the then Grand Junction Line, have been extended from time to time, to meet the requirements of the traffic, until, with the rolling mill, they now cover upwards of 17 acres of ground, not less than 30,000 square yards of this being taken up by covered or workshop area alone.

The visitors were first conducted by Mr. Ramsbottom and Mr. Webb, his assistant, to the rolling mill, where the operation of rail making was seen in all its stages, from the crude pig iron to the finished rail, a number of rails being also rolled in 24ft. lengths from solid ingots of Bessemer steel. The visitors were also shown a collection of specimens of steel rails made at these works, which had been rolled, in some cases, from the solid ingot, and in others from the ordinary pile, the body being composed of iron and the top and bottom slabs of steel, the slabs being rolled down, either from the ingot or from the crop ends of steel rails. These specimens, from the fineness of the grain and the excellence of the weld between the steel and iron, were much admired. It may be noticed here, as a proof of the superiority of the steel rail, that near the Crewe station several lengths of iron rails were replaced about two years ago by others of steel, which are, at present, but slightly worn, whereas the original iron ones had to be renewed about every twelve months, both webs being worn out.

The tilt hammer forge and mill rolls are driven by a pair of Boulton and Watt's horizontal engines of 150 nominal horse-power.

There are, altogether, twenty-three furnaces, the yield of finished rails being nearly 15,000 tons per annum.

Leaving the rolling mills, the engine works were next visited, commencing with the forge, where the engine tyres, axles, and heavier forgings, such as wheel spokes, rim pieces, coupling and connecting rods, together with fire-box roof stays and portions of the motion are forged ready for the smith to finish.

Adjoining the forge is the scrapyard, where a couple of shearing machines cut the scrap into convenient lengths for "piling," which is done by a number of boys in the forge, the scrap having previously passed through the cleaning machine, consisting of a revolving cylinder, into which the scrap is thrown. The pile is afterwards drawn down, faggoted, and worked up in the usual manner.

We here notice the method of welding the wheel-spokes—required for the solid wrought iron wheels—to the rim pieces. The spoke already hammered to shape, and the outer end heated to a welding heat, is dropped between a pair of dies placed under the hammer in lieu of the usual anvil block, and held in a vertical position, with the heated end projecting about an inch past the face of the dies. On this, the rim piece, also heated, is laid, the two being welded firmly together, and dressed on the edges and rim in a few blows. Of the grate bars used in the locomotive fireboxes about 800 tons are used per annum; and for rolling this and the smaller sections of bar-iron there is a 10in. train rolling mill, driven by a double cylinder horizontal engine, built locomotive fashion, with longitudinal frames of cast iron carrying the crank shaft, and between which the cylinders are bolted, the whole resting on a stone foundation.

There are twelve furnaces in the forge arranged in pairs, the waste heat being economised by vertical boilers fixed between them. These boilers, which are fitted for smoke burning, are very simple in arrangement, consisting merely of a cylindrical shell with round ends, surrounded with a casing of brickwork, between which and the boiler the flame passes, the chimney being carried at the top of the brickwork shell.

Passing on to the smithy, the attention of the visitors was especially directed to the method of forging the solid wrought iron wheels. The spokes, with their attached portion of the rim, the forging of which we have already noticed, are here welded together at the butt ends to form the boss, in such a manner as will form a segment of the intended wheels. These segments are then laid together, a hoop passed round the rim, the whole tightened up, and the welding of the boss centre completed, thus forming one solid mass, independent of any further operation. The boss which, from the ridge shape of the butt end of the spokes, is dished on each side, is then heated and laid on the anvil of a steam hammer. A disc, or boss-plate, also heated, being laid on the boss, is first struck by the hammer (the head of which is of small diameter), on the centre, so as to curl up the edges, and allow the scoriæ to be driven out, and then hammered round the edge by a number of rapid blows, the wheel being turned round on the anvil for that purpose, the operation being repeated for the other face of the boss; the whole is then dressed ready for the lathe.

The arrangement of the hammer, specially adapted ,for the purpose of "bossing," consists of a pair of cast iron girders, between which the steam cylinder is bolted. These girders are carried by cast iron columns at the ends, and are of sufficient span to allow of space round the anvil block for manipulating the wheel. The hammer weighs about 10 cwt., and is double acting.

A similar arrangement is used for welding the plates required for the locomotive frames. The circular hearths, used for bossing and heating the frame plates, are placed under the girder so that the wheel or plate can be lifted direct from the fire to the anvil. To the framing fire has been fitted a deflector, which can be raised or lowered at pleasure, consisting of a plate bent down the middle of its length to about a right angle, and lined with fire bricks. The ends of the plate to be welded are laid about 4in. apart in the fire, and the deflector lowered; the flame rising from the fire strikes the inclined sides of the deflector, and is thrown back on the top surface of the framing plate, which is free from fuel, producing a welding heat in a very short time.

The forge and smithy have an area of about 5000 square yards. There are, altogether, 15 steam hammers, varying from 6 to 50 cwt., and over 100 smiths' hearths, about 20 of which are employed in wheel making alone. Some idea of the amount of work done may be gathered from the fact, that at present over 4000 tons of scrap iron, in addition to the ordinary merchant bars, are worked up annually.

The boiler shop, contiguous to the smithy and forge, was next visited. It consists of a main building, down the sides of which the boilers in course of erection, and the bending rolls, punching, shearing, and other machines, are arranged, the whole being traversed from end to end overhead by a travelling crane. The smiths' hearths, steam rivetting machine, and the tender tank shop occupy wings at each end, while in the adjoining yard are placed the plate heating furnace and bending blocks and in addition to the manufacture of tender tanks, ordinary repairs, and other work, over 120 locomotive boilers are turned out per annum from this department.

The travelling crane already referred to was the chief point of attraction, and was minutely examined by the visitors. It consists of transverse hollow or box girders of plate iron, at the ends of which are fixed the carrying wheels. The longitudinal roadway is made of the ordinary permanent way rail, carried by cast iron brackets bolted to the side walls, the crab running on rails rivetted on the top web of the transverse girders. The method of driving is an arrangement of Mr. Ramsbottom's, first adopted in this crane, but which he has since carried out to a greater extent in other parts of the works. It consists of an endless cotton cord of small diameter, and very light, driven at a high velocity, and running down the ship on grooved slippers or guides, pulleys being dispensed with. From this cord, which in its course is carried across the traverser, all the motions are taken. Attached to the crab, and under the control of the attendant, is a sliding bar carrying two pulleys, between which the cord runs; by this means he is enabled to deflect the cord, and press it into grooves cut in the edge of a horizontal wheel, the motion thus communicated being afterwards reduced through a train of worm and spur wheels to the chain barrel. The reverse movement is obtained when the cord is applied on the opposite side of the wheel, and a second, or quick speed, by means of another groove of less diameter cut in the same wheel. The cross and longitudinal motions are worked in a similar manner. This crane lifts a weight of 6 tons at the rate of 4ft. 6in., while moving across and down the shop, at the rate of 50ft. per minute.

Passing on to the fitting and turning shop, the various details of locomotive work were seen in process of mauufacture, from the forged to the finished state, there being nearly 200 machines of all descriptions, from the small bolt lathe or nut-cutting engine to the cylinder boring mill. The engine cylinders are here bored in pairs, the different machines being so arranged as to be within the range of a wrought iron jib crane placed near them. After planing, the cylinders are removed to a template, consisting of a base plate carrying cast iron standards, between which the cylinders are dropped, the bolt holes in the cylinder flanches being marked off corresponding holes in the standards, such accuracy of work being thus obtained as to allow of damaged cylinders being replaced by others in a finished state, without any additional fitting, and which has been done in several instances. After the bolt holes have been marked and drilled, the cylinders are fitted with steam chest covers, glands, &c., and bolted together. The lifting and moving about of the cylinders in this stage of the work is effected by means of a long shaft overhead, from which chains are suspended at the different points required, the cylinder or other object being raised or lowered by the revolution of the shaft, which can be started or stopped at pleasure. We notice this as a good example of a cheap and serviceable crane, where power is applied at different points.

This shop is also fitted with a number of auxiliary tools, specially designed by Mr. Ramsbottom for these works; amongst others we remarked a machine for squaring bolt holes in cylinder covers, pipe flanches, glands, &c. This machine, which is simple in arrangement, consists merely of an upright girder, to which is bolted a long socket. In this socket slides a vertical forcing ram, with the end recessed to receive the point of a taper-toothed drift, the entering end of which fits the hole to be squared. The cover flanch, or other object, is carried by a table bolted to the upright. The machine is driven in the usual way, and forces the drift through at one stroke of the ram.

The short copper bolts used to stay together the inner and outer shells of locomotive fire-boxes, after being cut to length in the boiler shop, are here straightened and centred at each end. The tool used for this purpose consists of three rollers, one of which is movable on an eccentric spindle, so as to allow of the bolt being dropped in between them, when the movable roller forces it into contact with the other two, while a pair of square centres are simultaneously brought to bear on the ends. The stay thus straightened and centred is dropped out underneath, and is found sufficiently true to allow of its being chased in the lathe without further preparation.

Several other tools, which our space does not admit us to describe, also attracted the attention of the visitors, who minutely examined them, and other features of interest in this department.

Leaving the fitting shop, and passing in the adjoining yard the tyre furnace and bending mill, the spring smithy, which is fitted with furnace and machinery for the manufacture of the locomotive engine and other springs used by this department, was next visited.

The steel from which the engine springs are made is received in long bars, which are first cut by a small shearing machine into plates of the required length. The centre of the plate being then heated, is indented by a conically pointed punch fitted to the same machine, a nipple or projection being thus formed on the under side; the ends are then heated and passed between eccentric rolls, which, at each revolution, strike the plate and taper it down. The ragged ends are afterwards cut off. The nipple referred to, dropping into an adjustable stop attached to the machine, serves as a guide for the length. The plates are then bent to shape, hardened, and tempered down in the usual manner, built up into the complete spring, and the buckle shrunk on, the plates being prevented from moving endways by the nipple of one plate fitting into the corresponding recess of the one below it, which thus dispenses wtih a centre bolt and the consequent weakening of the plates. It appears that during the past twelve months, in order to supply the new engines and keep up the repairs, upwards of 10,000 springs of all kinds have been manufactured.

The erecting shop, next visited, is about 240ft. long by 80ft. wide, and is capable of accommodating 24 of the largest class of engines. It is divided into two bays by a row of cast iron columns down the centre, the engines in course of erection standing on four lines running the length of the shop. Four excellent travelling cranes, made by Moore, of Liverpool, are here fitted; they run on cast iron girders carried by the side walls of the building and the columns in the centre, and are driven by an endless rope moving at a low velocity, and carried along the walls by guide pulleys, the motion being transmitted through friction wheels and cross shafts to the traverser and crab. Each crane lifts a weight of 20 tons 1ft. 6in., and moves it along and across the shop at the rate of 30ft. per minute.

This shop has been fitted with several portable tools designed by Mr. Ramsbottom, for the purpose of boring cylinders, dressing the steam port faces, and axle-box girders, when worn. These machines are driven by cords off the line of shafting moving down the centre of the shop, and are so arranged that all the operations may be performed without moving the engine from its berth, or in any way disturbing the parts to be acted on.

The steam port facing machine consists of a bed plate carrying a pair of disc weeels, to which the scraping tool is bolted, and driven by a centre screw acting simultaneously on both wheels; the feed motion being self-acting, and the whole so arranged that it can be introduced into the narrowest steam chest.

The hornblock dressing machine is similar in construction and in the method of driving, but is made long enough to reach across the engine, so that each block can be dressed at the same time.

The cylinder boring machine consists of the ordinary boring bar, to which the boring head is keyed fast and driven by worm wheels. The driving pulleys are made in two halves, so as to be applied at any point in the length of the line of shafting.

Adjoining the erecting shop, and running its full length, is a building about 40ft. wide, where the frame plates are slotted and drilled, six plates being cramped together and laid on the machine at the same time. The splasher and handrail are likewise finished in the same way, ready for the erector.

The locomotive boilers are tried in a yard lying between the erecting and wheel-turning shops, one end of the yard being used in connection with the foundry, and the other as a store yard for spare wheels and axles.

The wheel-turning shop is fitted throughout with the heaviest class of lathes, slotting and drilling machines, required in the finishing of wheels, axles, and tyres, to which work this shop is exclusively devoted.

The machines are arranged along each side of the shop, the centre space being reserved for the stowage of the wheels, axles, &c., in progress; and a pair of travelling jib cranes running on single rails, bolted to the floor, supply the necessary lifting power. These cranes consist simply of box girders of plate-iron forming the base, and carrying a strong cast-iron pillar, round which the jib, with its attached lifting gear, revolves. Mr. Ramsbottom has carried out the system previously noticed, when speaking of the boiler shop crane, of driving by means of a light cotton cord running at a high velocity; the constructive details, however, present different characteristics. The crane pillar is guided at the top by rolled iron girders of a double T or trough section, carried on edge from the roof, the motion of the cord being transmitted by a vertical spindle passing down the centre of the crane pillar. From this spindle the lifting, lowering, and transverse motions are taken by means of friction cones, worm, and spur gearing, the whole running on a pair of wheels, carried at the ends of the hollow girder forming the base. Each crane is capable of lifting a weight of four tons at the rate of 6ft. per minute, and traversing 40ft. in the same time.

The repairing shops which adjoin the wheel shop have a total area of 5800 square yards, and afford standing room for upwards of 70 large engines. The smaller of the two shops is fitted with four 15-ton travelling cranes, made by Moore, of Liverpool, and worked by band from the floor by means of chains working in grooved wheels. The larger shop is at present being fitted with four travelling cranes, each capable of lifting 20 tons. Two of these cranes have been finished, and were seen in operation; the others were in progress, and it was expected would soon be in their places. These cranes run on longitudinal girders, in a similar manner to those in the erecting shop; and Mr. Ramsbottom has carried out in them the cord system. The details of the arrangements are, however, different; the cord being guided across the traverser, and returning in nearly the same vertical plane, the motion of the pulley, which is double grooved, being reversed when either the upper or under cord, as the case may require, is pressed into the corresponding groove.

The erecting and preparing shops turn out per annum about 100 new engines, and keep in repair the greater part of the stock, which at present exceeds 11,000 engines.

Our limited space does not allow us to describe, the tender, joiner, and pattern shops, situated in another part of the works.

The town and works are supplied with gas, made at the Company's Gas Works.

In order more effectively to knit together these works, which spread over a great surface, a tramway has been laid down at 1′ 6″ gauge since May, 1862, for the purpose of carrying stores and material of all kinds from one part of the works to another, together with the various parts of the engines being built or under repair.

The tramway is now about ¾ths of a mile long, and is worked by a small locomotive engine, named "Tiney." In its course it traverses curves of 15ft. radius each, no difficulty being found in going round these curves, with loads of 12 to 15 tons, or in taking 7′ 6″ wheel forgings or tyres on edge, by means of trucks specially adapted for the purpose. This engine has four wheels coupled, inside cylinders 4½ diameter, and 6″ in stroke; the wheels are 15in. in diameter on a base of 3ft. The total heating surface is about 12 square feet; the boiler is fitted with a No. 2 Giffard's injector, and carries a saddle tank capable of holding 28 gallons. The total weight, in working order, is 2½ tons. The line is in most cases parallel to the ordinary rails in the works, and the engine is used to fly-shunt the large waggons in all cases where it can be brought to bear.

REVIEWS AND NOTICES OF NEW BOOKS.

L'Art Naval a l'Exposition Universelle de Londres de 1862 ; *Description et Discussion de tout ce que l'Exposition présentat de plus remarquable dans la Marine.* Par le Contre Amiral PARIS, C.B., &c. Large 8vo., 350 pp., with 20 engraved Plates, in separate cover. Paris: Arthus Bertrand, 21, Rue Hautefeuille.

Although it is now more than a year since the International Exhibition was closed, the memoirs devoted to some of the more special features in its contents are only now appearing. The work—the subject of this notice—treating upon the contents of Class XII., written by Admiral Paris, of the Imperial French Navy, has just been published, as above.

When so able a man as Admiral Paris addresses himself to any subject, the natural expectation is that the result of his labours will be highly useful to the class to which his work is dedicated. In the works previously published by the same author, a vast amount of not only novel, but useful and thoroughly practical and exact information was comprised within reasonable limits; and on the present occasion he has succeeded in the highest degree in rendering both complete and interesting subjects of the greatest importance to maritime nations. How successfully Admiral Paris has accomplished the task which he undertook can only be ascertained by a perusal of the book itself.

The first part treats of the different constructions of ships of war, and the various types employed, giving a short historical sketch of various periods of transition, and the changes effected; and he devotes a large portion of the first division of his book to iron-plated ships and iron constructions. He has treated the latter part of the subject admirably—indeed, in such a manner as only a highly scientific naval officer, of great experience in steam, combined with practical seamanship, could do; and we doubt if any officer in our service could have treated the subject equally well.

The second part of the book is devoted to a description of the various engines, machines, and works in connection with naval architecture, which were exhibited in the International Exhibition of last year. The various articles contained in Class XII. are critically described, and the several interesting chapters devoted thereto are worthy of being translated into English and re-published; and this, we trust, will be done. Accompanying the text are 20 large plates, executed in an admirable manner, and illustrating with fidelity the several subjects.

We recommend Admiral Paris's highly valuable work to the officers of the Royal Navy, as well as to engineers and others; and to every one who felt an interest in Class XII. of the Exhibition of 1862, Admiral Paris's book will supply the only really useful record which is available for scientific and technical reference.

We regret that, from the late period at which we received the book, it is impossible for us to render it ample justice by now reviewing it at length; but we hope next month to be able to give a more extended notice of its contents.

A Treatise on Parabolic Construction of Ships, and other Marine Engineering Subjects. By J. W. NYSTROM, C.E. Philadelphia: J. B. Lippincott and Co. London: Trübner. 1863.

We have, in previous numbers, given Mr. Nystrom's views somewhat at length (see pp. 102–105, ARTIZAN); and we cannot do better than refer our readers to the book itself for further information.

A Manual on Earthwork. By ALEX. J. S. GRAHAM, C.E. London: Lockwood and Co. 1863.

An excellent book, appropriately dedicated to Mr. R. P. Brereton, the successor to the business of the late Mr. Brunel.

As a really handy book for reference we know of no work equal to it; and the railway engineers and others employed in the measurement and calculation of earthwork will find a great amount of practical information very admirably arranged, and available for general or rough estimates, as well as for the more exact calculations required in the engineers' contractor's offices. The *Manual* could not have appeared more opportunely than at this time.

Pocket-book of Mechanics and Engineering; containing a Memorandum of Facts and Practice and Theory. By JOHN W. NYSTROM, C.E. Philadelphia: J. B. Lippincott and Co.; London: Trübner and Co. 1864.

We have just received the eighth edition of this excellent Pocket-book. On previous occasions we have expressed so high an opinion of the book that we can but repeat the praise so deservedly bestowed.

In this edition, Mr. Nystrom has added several pages of new matter, and much that is original. Many of the errors which were unnoticed in previous editions have been corrected, and, on the whole, it may be said Mr. Nystrom's Pocket-book contains a great deal that cannot be found elsewhere. The high estimation in which it is held amongst practical men is an evidence of its usefulness.

Treatise on Mills and Millwork. Part II. "On Machinery of Transmission and the Construction and Arrangement of Mills." By W. FAIRBAIRN, Esq., C.E., LL.D., F.R.S., F.G.S. London: Longmans. 1863.

As a further instalment of the promised series, Dr. Fairbairn has given us a useful collection of treatises on wheels, shafts, and couplings, engaging and discugaging gear, and on mill architecture. In the portion of the work devoted to corn, cotton, flax, silk, and woollen mills, will be found some useful examples of modern constructions. Added to these, there are descriptions of oil, paper, and powder mills, and a short account of the manufacture of iron—all useful in their way.

[We regret that other books received have come to hand too late to enable them to be noticed in the present number.]

NOTICES TO CORRESPONDENTS.

G. S. (Cardiff.)—The following is a formula for ascertaining the speed of a screw ship in knots per hour, calculated from the velocity of the screw, and compiled from formulæ given in Nystrom's *Pocket Book of Mechanics*, &c.:—

$$M = \sqrt[3]{\frac{81\,D^3\,n^3}{480{,}000\,\Sigma}\,(L\,S\cos W + 0{\cdot}110)}$$

in which—

M = number of knots run by the vessel per hour.
D = diameter of screw.
n = number of revolutions of screw per minute.
L = length of blade parallel with centre line of propeller.
S = slip of screw.
W = angle of the blades at the periphery.
Σ = area of resistance (to vessel) in square feet.

We would also refer you to a "Table of Speeds of Screw Propellers in Knots and Statute Miles per Hour," given in THE ARTIZAN volume for 1856.

W. J. C.—We await the receipt of the promised particulars.

E. R. W.—The subject is in hand.

J. G. (Edinburgh).—We are glad to hear you have succeeded, and that we had hit upon the cause of your previous non-success.

G. B.—We have referred your inquiry to Professor Rankine, the author of the Paper to which you refer, and which was read at the late meeting of the British Association at Newcastle-on-Tyne. We will send you his reply.

VACUUM.—You will be able to obtain a fair vacuum from your air-pump by assuming a speed of not less than 90 and not exceeding 100ft. per minute. A greater speed would, in our opinion, materially injure the vacuum. In general, a speed of the air-pump bucket half that of the steam piston will give a very good result. As regards the india rubber valve alluded to in your letter, the following proportions will be the best:—

Height of aperture = $\frac{2}{9}$ths of diameter of air-pump.
Width of aperture = $\frac{5}{6}$ths " "

Or else—

Area aperture : area of air-pump :: 54 : 229.

T. J., and other correspondents whose letters we have received since going to press, will, where possible, be answered through the post, or in our next issue.

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

RAILWAY COMPENSATION CASE.—In the Lord Mayor's Court, on the 19th ult., before Mr. Russell Gurney, Q.C., the Recorder, and a special jury, Mr. Duffield, of Long-lane, Smithfield, and Aldersgate-street, whose repository is about to be removed to make way for the Smithfield extension of the Metropolitan Railway, claimed the sum of £13,000 as compensation for the leases, removal, depreciation of stock, loss of trade, and the consequent injury that would accrue to his business. The evidence was of a very conflicting character. Ultimately the jury gave their award as follows:—£2500 in respect of the leases, £200 for the fixtures, £100 for removal, £900 for depreciation of stock, and £1200 for loss of trade, making a total compensation of £4900, or £8100 less than the amount claimed.

THE METROPOLITAN RAILWAY.—COMPENSATION CASE.—This case—Samuel *v.* the Metropolitan Railway—has been recently tried at the Sheriffs' Court, Red Lion-square. The claim, as originally proposed, exceeded £18,000, and the company had offered £2000. The claim, as now submitted, was £7700. It appeared that Messrs. Samuel held an unexpired lease of their premises for 20 years, at £87 per year. It was further proved that property in the neighbourhood had increased in value in consequence of the many undertakings in progress. The Under-Sheriff stated that the question in this, as in other similar cases, was a fair compensation, and not to allow the parties to make a profit out of the company. The jury, after some deliberation, assessed the compensation at £2250.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

DRAINAGE OF AN IRISH LAKE.—A gentleman has performed a great drainage feat in the county of Roscommon. About five years ago he purchased an estate on which was a lake called Keoghville, covering 137 acres, with a depth of water varying from 5ft. to 16ft. Mr. Wallace made an arterial cut two and a half miles long connecting the lake with the river at Milltown Pass. This cut is 4ft. wide at bottom and 13ft. wide at top, and in some places 18 feet deep. For a mile it passes through solid rock, which had to be blasted. The result is that the lake has disappeared, and in its place is a large tract of rich alluvial soil, giving every promise of luxuriant vegetation.

A MAGNETIC MOUNTAIN has been discovered in Swedish Lapland, and the vein, which is several feet thick, promises to be one of the richest sources of natural magnets at present known. A natural magnet weighing 400lbs. has already been obtained, and larger ones may be expected. The extraordinary magnetism of this mountain suggests the question whether the magnetic pole of the earth must not be sought in Lapland rather than in Siberia.

THE CONTRACT FOR THE NEW INDIA AND FOREIGN OFFICES, to be erected by Mr. Scott, the architect, has been let to Messrs. Smith and Taylor, whose tender, £195,573, being the lowest, was accepted.

TRACTION ENGINES.—A public trial has been made at the Chatham Dockyard, of a new description of traction engine invented by Messrs. Aveling and Porter, of Rochester, which has been brought into use at the Dockyard for conveying the machinery and other heavy materials used in the improvements now in progress at the establishment to and from the Dockyard Works. Three of the engines, each having a heavy load attached, started from Messrs. Aveling and Porter's works, on the Strood side of Rochester-bridge. The first engine weighed 12 tons, and was one of several on the eve of being shipped to Kingston, Jamaica. Attached to the engine were two lorries, each containing three cast-iron girders, to be used in the works now in progress at the Dockyard. The united weight of the girders was 18 tons, and of the two trucks 5 tons. To the second engine were attached five empty lorries, each weighing 2½ tons, and constructed to carry 7 tons each. The last engine had attached a large steam thrashing-machine, and some other agricultural machinery. The three engines with their loads started away over Rochester Bridge, and through the streets of the town towards the Dockyard, the speed varying from two to four miles an hour. The ascent of Star Hill, which has an incline of 1 in 12, was made by all three engines, with their respective loads, without the least apparent difficulty, and without any stoppage, the rate being two miles and a half per hour. In the passage through the crowded streets of Chatham to the Dockyard no inconvenience whatever was experienced, the engines adapting themselves to every variety of road, and travelling with a uniform rate of speed. Attached to one of the engines is an appliance for loading and unloading heavy weights, and on the train of trucks being stopped the engine was detached and brought round to the trucks conveying the girders, when, by means of the lifting apparatus, the latter were lifted from the lorries and deposited in the spot selected for them. Each of the engines started from the factory with a stock of 10cwt. of coals, which is sufficient for eight hours' consumption. The trials were pronounced in all respects satisfactory.

THE POPULATION OF THE GLOBE.—A professor of the University of Berlin has recently published the result of his researches as to the population of the earth, according to which Europe contains 272 millions; Asia, 720 millions; Africa, 89 millions; America, 200 millions; and Polynesia, 2 millions—making a grand total of 1283 millions of inhabitants. As in places where deaths are accurately registered the annual mortality is at least 1 in 40, the number of deaths must be about 32 millions every year, which gives 87,761 per day, 3653 per hour, and 61 per minute, so that every second witnesses the extinction of one human life. Another calculator states that the number of persons who have lived on the earth since the creation is 36,627,843,275,075,855!

IRON STREETS.—A project has been broached in New York for paving the streets with iron, and conducting the traffic by steam carriages moving on these iron floors. It is urged that the saving to clothing, furniture, and goods, from damage by dust and mud would be enormous; that the resistance on clean iron floors would be small, the wear on carriages slight, and the noise but trifling in comparison with what it is at present. Shoes, it is represented, would wear much longer on iron-side walks than on stone.

ASSESSMENT OF RAILWAYS, GAS, AND WATER COMPANIES.—The recent decision in the Court of Queen's Bench upon the subject of rating railway and other companies, who either destroy rateable property, or occupy land and premises beneficially, have induced many of the metropolitan parishes entirely to revise their assessments in this particular. The assessment-rate and appeal committee of the parish of St. Pancras have, therefore, taken into consideration the subject in relation to the assessment of the London and North-Western, the Great Northern, the North London, the Midland, the Metropolitan and the Hampstead Junction Railways, now existing, or in course of progress in that parish; as also the Imperial and Chartered Gas Company, the New River and West Middlesex Water Companies, the Electric Telegraph, and London Cemetery Companies; and they find that the assessment on the rate made on the 11th April of the present year was £63,936, a sum totally disproportionate to the amount of land and premises occupied beneficially, or of property destroyed, and they have therefore recommended to the representative vestry to increase the assessment upon these properties by a sum of £30,542, or, in the aggregate, to the sum of £94,478. The recommendations of the report have all been adopted.

LIGHTNING CONDUCTORS.—The Bishops Waltham Clay Company have made a brick with a hole through a moulded portion of it, for the purpose of securing lightning conductors.

NEW MODE OF USING NAPHTHALINE.—Mr. Serbat has taken out a patent in Belgium, for using naphthaline pure or mixed, or in combination with other substances, for lubricating machinery. It is caused to enter either into substances prepared for lubricating purposes, or into natural oils, or greases, or artificial oils, by dissolving it in, or merely mixing it with them. 100 parts of naphthaline are mixed with from 10 to 25 parts of oil or greases and stirred; when the paste produced in this manner has become cold, it may be used for lubricating axles, shafts, gearings, or other mechanical organs. For lubricating spindles and other articles on which oil is usually applied, add from 5 to 20 parts of naphthaline to 100 parts of oil; heat the mixture in warm water until the naphthaline is dissolved, and then shake it until the mixture is cooled down. Such oils, mixed with naphthaline, are more unctuous, they last longer, and are consequently more economical than common oils.

INJURIOUS ACTION OF LEAD PIPES ON WATER.—A discovery has recently been made through which the water supplied by leaden pipes may be obtained by the consumer as pure as from the original source. Dr. H. Schwartz, of Breslau, has discovered a means by which the portion of the lead forming the interior surface of the pipe may be converted into an insoluble sulphide, the consequence being that the water passing through will be as free from impurity as if passed through glass. Dr. Schwartz affects this conversion by simply passing a strong solution of the sulphide of an alkali through the pipe to be acted upon, and the process is completed. This solution, which is either a sulphide of potassium or of sodium, is used at a temperature of about 212 degrees Fahrenheit, and is allowed to act on the metal from 10 to 15 minutes. It is stated that in practice the boiling solution of caustic soda and sulphur is found to answer every purpose.

THE "JANE," PATENT IRON-TANK SHIP, has arrived in the Mersey from Philadelphia, with a cargo of crude petroleum oil in bulk, belonging to the Liverpool and Romsey Oil Refining and Chemical Works Company (Limited). This is the first iron-tanked vessel with petroleum that has arrived in this country. The *Jane* was specially constructed for carrying oil from America to the company's works at Romsey, where it is discharged into hermetically sealed floating tanks, which are moored in the river. The vessel made the passage in twenty days.

NAVAL ENGINEERING.

THE "SCYLLA," screw corvette, 1467 tons, 400 horse-power, underwent her trial trip at the measured mile off Maplin Sands on the 25th ult. The vessel made six runs at the measured mile with full boiler power, and attained an average speed of 10·837 knots, with a draft of water 17ft. forward, and 19ft. aft. The revolutions of the engines were 57, pressure of steam, 20lb., and vacuum, 24. Two runs were also made with half boiler power, giving a result of 9·092 knots per hour, revolutions, 45, pressure of steam, 20lb., vacuum, 24. There was a slight force of wind from S.S.W., and water smooth. The circle was turned at full boiler power, with helm port, 21 degrees, in 4 min. 55 sec., the diameter of circle being 405ft; at half boiler power, with helm starboard, 36 degrees, in 5 min. 30 sec., diameter, 419ft. Messrs. John Penn and Son are the builders of the engines, which are fitted with Smith's screw propeller, diameter, 16ft., pitch, 3ft. 6in., length, 3ft. The trial was considered very satisfactory.

THE "PRINCE CONSORT" was laid down at Pembroke as a line-of-battle ship on the same lines as the *Gibraltar*; but was afterwards cut in two, lengthened 23ft., and, like the *Ocean*, reduced to a two-decker. She was first called the *Triumph*, but this name was altered to the *Prince Consort*. Her launch took place in June, 1862. The dimensions are:—Length over all, 277ft.; length between perpendiculars, 273ft.; keel for tonnage, 232ft. 3¾in.; breadth extreme, 58ft. 5in.; ditto for tonnage, 57ft. 2in.; ditto moulded, 56ft. 4in.; depth of hold, 19ft. 10in.; tonnage, 4045 26-94 tons; ditto Board of Trade, 3521·34 tons; tonnage of engine room, 1913·73 tons; ditto register, 1607·6 tons; displacement when light, 2924 tons; ditto estimated when loaded, 6328 tons; estimated draught when loaded, 23ft. 7in. forward, 25ft. 2in. aft. Her draught, when launched, was 12ft. 11in. forward, 16ft. 10in. aft.; mean draught, 14ft. 10½in. The engines collectively of 1000 horse-power (nominal) are from the manufactory of Messrs. Maudslay, Sons, and Field, and are seated 15ft. before the mainmast; they are termed "horizontal double piston rod." The horizontal double action air-pump is worked direct from the engine. Each of the engines fitted with box slides; they are worked by double eccentric and link motion, and are provided with metallic slide valves. The air-pump valves are of india-rubber, with metallic valves to discharge through the sides of the ship. The air-pumps are 29in. in diameter, and have a 4ft. stroke. The inside diameter of the steam cylinders is 92in.; they are steam jacketed. The diameter of the main steam pipes is 23in. The pistons are fitted with metallic packing, and not with hemp as heretofore. There are also in the engine-room two small auxiliary engines of 12in. diameter. Each of these is fitted with a pump for filling boilers from the sea; together they are capable of supplying the requisite amount of water when the main engines are working full boiler power. She has in addition a double 7in. pump, which can be worked by hand or steam, capable of supplying a sufficient quantity of water for working half-boiler power, and arranged so as to pump on deck or overboard, and to draw water from the bilges or the sea. The eight boilers contain 3840 tubes, each of which is 6ft. long by 2⅝in. outer diameter, and 2¼in. inner diameter. By the fore boilers the power of 800 horses (nominal) can be obtained, and by the other 200 horses, calculated at 7lbs. effective pressure per square inch. The gun metal screw propeller is four bladed; it weighs about 15½ tons, and overhangs, or, rather, has no outer bearings. The diameter is 21ft., and the pitch, on Maudslay's principle, can be altered from 20ft. to 25ft. mean pitch. The stern bracket is surfaced up, and the boss of the screw is surfaced also; the machinery is arranged so that the screw-shaft can be carried forward to close the opening entirely where the two surfaces meet. The *Prince Consort's* screw shaft is fitted with a disconnecting clutch and friction brake, by which, when the ship is under canvas only, the screw will be allowed to revolve freely in the water. The brake can be used when it is necessary to stop the screw, and reconnect it with the engines for the purpose of resorting to steam. In the fore stroke-hole there is a spare blade for use in case of accident; like the others its flange is perforated with slotted holes for the reception of the screws which fasten it to the boss. The blades are twisted slightly, and become much thinned towards the outer ends. The engines and machinery weigh 750 tons; the cost is about £50,500, and the manufacturer obtains in addition £1 per horse power (£1000) for placing them on board. The contractors' trial of the engines of this iron-plated screw steamship took place on the 24th ult., outside Plymouth breakwater, and proved completely successful. The mean speed of the six runs at the measured mile was 13·132 knots an hour; the revolutions of the engines were 56' per minute. On the 14th ult. the *Prince Consort* completed the last of the series of trial trips. The result of four runs at the measured mile gave a mean speed of 12·093 knots; mean revolutions 56¼. With two large boilers forward, estimated at 300 horse-power, the mean speed was 9·127; revolutions 40. With four small boilers aft, estimated at 400 horse-power, the speed was 10·33 knots; revolutions 41½; and with two small boilers aft (200 horse-power), the speed attained was 7·84; revolutions 33.

A NEW FRIGATE, CALLED THE "BELLEROPHON," is to be built at Chatham, from the plans of Mr. Reed, which will eclipse anything that has preceded her in the shape of iron

ships. The trial target, which is now under construction, is formed of 10in. iron frames, about 2ft. apart, covered first with iron nearly 2in. thick, then with teak 12in. in thickness, and finally with 6in. armour plating; and should they be found to succeed on the occasion of the trial, the *Bellerophon* will be covered in exactly the same manner from stem to stern. Her engines will be of the most powerful description, to steam at least 14 knots per hour, and this, coupled with her enormous strength, and her shot-resisting power, will render her by far the most formidable of the iron vessels yet constructed.

The French Steam Ram "Magenta."—The *Opinion Nationale* gives the following description of this new steam ram. She is higher out of the water at the bows than the stern; her masts are short and thick, and the bows culminate in a gigantic spar or ploughshare. The upper deck is flush, and with the exception of two bow chasers, there are no guns upon it; close to the smoke pipe is a shot proof turret, whence orders can be communicated to every part of the ship. In action the crew are all below, and the captain, his signal officers, and a few picked marksmen occupy the turret. The *Magenta* has two gun decks, each armed with 24 breech-loading guns, throwing a 60lb. shot. All the guns are protected by iron plates, but the iron casing stops short at the bows and stern. The engines (1000 horse-power nominal), can be worked up to 2700. Her speed on an even keel is from 13 to 14 knots, and her consumption of coal 130 tons per day. Her length over all is about 295ft.; extreme breadth about 57ft.; her displacement 6000 to 7000 tons.

Naval Appointments.—The following appointments have been made since our last:—W. Anderson, Chief Engineer, to the *Asia*, for the *Odin*; T. H. Dawkins, Acting Engineer, to the *Asia*, as supernumerary; W. F. Innes, Engineer, to the *Dauntless*, for the *Tender*; R. Harris, Engineer, and F. Pugh, W. M'Naught, and G. T. Stronach, Assist. Engineers, to the *Medusa*; W. H. Brimfield, of the *Wye*, confirmed as First-class Assist. Engineer; W. H. Barker, of the *Topaze*, promoted to Acting First-class Assist. Engineer; F. Stow, Chief Engineer, to the *Indus*, for special service; H. Brown, Chief Engineer, to the *Challenger*; J. Davis, Chief Engineer, to the *Lily*; S. H. Dawkins, Acting Engineer, A. J. Trout, J. D. Lamont, M. Baird, R. Young, and G. R. Beer, Assist. Engineers, to the *Nile*, as supernumeraries; T. F. Hill, Chief Engineer, to the *Fisgard*, for the *Wolverine*; J. Copplestone, Assist. Engineer, to the *Indus*, for the *Constance*; G. Park, Chief Engineer, to the *Indus*, for the *London*; E. Barrett and J. Brand, Assist. Engineers, to the *Cumberland*, as supernumeraries; J. M'Laren, in the *Cumberland*; E. Carling, in the *Indus*; M. M'Intyre, in the *Adventure*; A. B. Luckie, in the *Victoria*; and A. T. Pringle, in the *Wye*; W. Gentles, of the *Cumberland*, for the *Wildfire*; D. M'Vean, of the *Fisgard*, for the *Bann*, and T. Spence, in the *Supply*, promoted to First-class Assist. Engineers; J. Bannatyne, in the *Centaur*, D. Storrar, in the *Cygnet*, D. M'Intyre, in the *Argus*, and R. Findlay, in the *Cormorant*, promoted to Acting First-class Assist. Engineers; T. T. Murray, Chief Engineer, to the *Gibraltar*; W. Stell, Chief Engineer, to the *Pelorus*; J. Gillies, Chief Engineer, to the *Scylla*; R. Anderson (a), Engineer, to the *Supply*; J. Snell, Engineer, to the *Scylla*; W. Skeen, Engineer, to the *Gibraltar*; W. Maxwell, Engineer, to the *Asia*, for the *Earnest*; J. L. Davies, Engineer, to the *Indus*, for the *Delight*; F. W. Sutton (b), Engineer, to the *Indus*, for the *Royalist*; E. Taylor, Engineer, to the *Pelorus*; J. Annable, First-class Assist. Engineer, to the *Pelorus*; W. N. Sennett, Assist. Engineer, to the *Indus*, for the *Donegal*; J. Hopwood, Assist. Engineer, to the *Fisgard*, as supernumerary; W. Bowen, Assist. Engineer, to the *Scylla*; R. J. Morman, Assist. Engineer, to the *Pelorus*; G. O. Wilson, Assist. Engineer, to the *Russell*; W. Pilcher, G. W. Robins, and W. F. Cole, Assist. Engineers, to the *Gibraltar*; B. F. Pine, promoted to be Chief Engineer. G. Glasson, Chief Engineer, to the *Liverpool*; J. A. H. Marcus, Assist. Engineer, to the *Asia*, as supernumerary; J. A. Lodge, Engineer, and J. King (a), and W. Hawksley, Assist. Engineers, to the *Fisgard*, for the *Hydra*; A. Ritchie, in the *Dasher*, for the *Speedy*, and W. Landells, in the *Asia*, supernumeraries, promoted to First-class Assist. Engineers; B. G. Little, Assist. Engineer, to the *Fisgard*, as supernumerary; R. H. East, Assist. Engineer, to the *Indus*, as supernumerary; T. Lumley, Chief Engineer, to the *Indus*, for the *Research*; J. D. Lamont, in the *Nile*, promoted to Engineer; A. Lowton, in the *Orlando*, promoted to First-class Assist. Engineer; H. W. Wilkins, W. E. Blackburn, and E. Bolton, Assist. Engineers, to the *Asia*, as supernumeraries; J. T. Stockting, Assist. Engineer, to the *Dauntless*, for the charge of the engines of the *Argus*; R. E. Chiswell, Assist. Engineer, to the *Dauntless*, for the *Argus*; J. W. Hawes, Assist. Engineer, to the *Colossus*; J. T. S. Flynn, Assist. Engineer, to the *Cumberland*, as supernumerary; G. Tyril, C. J. Cock, and W. G. M'Buruey, Assist. Engineers, to the *Indus*, as supernumeraries.

The "Osborne" paddlewheel steam yacht, went out of Portsmouth harbour, on the 17th ult., to Stokes Bay for a trial of her machinery and her new paddlewheels, under the superintendence of Commander Brett and other officials of the Steam Reserve. The trial was considered satisfactory.

The Steam Frigate "Arethusa," 39 guns, 3141 tons, 500 horse-power, having undergone several important alterations in her machinery to enable her to work either by surface or injection condensation, or the two conjointly, was taken out of Sheerness Dockyard on an experimental trip of five hours on the 11th ult. During the trip the average revolutions of engines were 68 per minute; vacuum, 28lb.; and pressure of steam, 25lb. The trial was of a most satisfactory character.

The "Snipe," 5-screw steam gun vessel, 431 tons, 80 horse-power, recently underwent her final trial of machinery at the measured mile off Maplin Sands. The trial was pronounced highly satisfactory, the vessel's speed being 8·440 knots an hour, about a quarter of a knot greater than that of her sister ship the *Jaseur*.

The "Speedy," screw gun vessel, in commission for service at the Channel Islands, having undergone repairs to hull and machinery at Portsmouth, and received new boilers, was tested at the measured mile in Stokes' Bay on the 16th ult. She realised a mean speed of eight knots, and under high pressure slightly exceeded that rate. The machinery worked satisfactorily.

MILITARY ENGINEERING.

English and French Metal.—A third trial of French and English armour-plates took place at Portsmouth on the 2nd ult. The plates comprised four from the French firm of Petin, Gaudet, and Co., two of 4½in. and the remaining two of 5½in.; one from Messrs. John Brown and Co., of Sheffield, of 5½in.; and one from the Millwall Company, of 5½in., the average length of the whole being 15ft., and their breadth 3ft. 4in. Petin and Gaudet's two 4½in. plates received six and seven shots respectively, and both proved to be of inferior quality. They had both very extensive cracks and separations of the metal, and showed cracks of a greater extent than has been done by the French made plates on any former trial. Messrs. Brown's plate and that of the Millwall may be considered about equal, and as the best by far of the six tested. The French plates proved to be far below the average of "A 1" plates, and very inferior indeed to the two first plates which were tried at Portsmouth from the same firm. M. Gaudet, who was present during the trials, expressed his astonishment at the results as regarded his plates, and said that no such result had ever attended any trial of them in France.

The Armstrong.—At Fort Cumberland the Royal Marine Artillery, at Lumps Fort the Royal Artillery of the 6th Brigade; and on board her Majesty's ship *Excellent* the trained gunners, have been engaged in making a series of experimental rapid firing courses with shot and shell from the new "wedge" Armstrong 40 and 70 pounders. Similar experimental firing is taking place at other out-stations under competent officers, and each officer engaged in conducting the experiments will, at their close, forward his own report, independently of all others, to headquarters. The guns now under trial are the most perfect form of the Armstrong breech-loader extant. The whole of the experimental firing has not yet been concluded with all the guns under trial, but it has proceeded sufficiently far to enable a correct judgment to be formed of the gun's power and its suitability for service on board ship. The 70-pounder wedge gun under trial concluded its course after firing 200 shot and 50 common shell (Armstrong, but not built in segments). The target was placed at 2000 yards' distance out on the Horse Shoal, seaward. The charge of powder used for the shot was 10lb. and for the shell 9lb.; the latter containing 3lb. of powder as a bursting charge. Two different targets were used for shot and shell, that for the latter being built up of nine inch oak plank, as the shells were fired with a pillar fuse, and therefore required a resisting object of some solidity to strike against to cause them to burst. The practice made throughout with this gun was very fine; 65 shots were fired in 47½ minutes, and the target was struck 36 times. This was the longest period of firing at one time to which the gun was subjected, for the "keybolt" gave out on several occasions, and the gun became disabled until the armourer had removed the pin, and repaired the damage. The Armstrong armourer stationed at Portsmouth being present, examined the bolt by Colonel Longdon's directions, and gave it as his opinion that it was made from a similar metal to the gun. He suggested that he should be allowed to make a new steel bolt. To this the colonel at once acceded, and the new bolt was tried, and 64 shots were fired from the gun consecutively without any burring up of the metal on the wedges, or any serious damage to the bolt beyond the indentations which might be expected on the side of so small a piece of metal. The firing from the 40-pounder, also under trial, is not yet concluded. One of the 70-pounder shells burst at the mouth of the gun, but that was the only instance of the kind throughout its firing, and no cause could be assigned for it. With all the accuracy exhibited by both the guns, there was a great eccentricity of movement observed in the after course of the shots, and the general opinion which has been formed thus far of the wedge gun is that it is not in its present state at all fit for sea service.

Improved Ordnance.—A course of experiments is now in progress in the Royal Arsenal at Woolwich which promises important results. A 32-pounder cast iron service gun, strengthened on Capt. Palliser's plan, has been tested by firing a double-proof service charge of 36lb. of powder, and a cylinder gradually increased in size. The gun was fired upwards of 100 rounds without manifesting the slightest signs of giving way, and burst at the 107th round. The result is considered exceedingly favourable, and has been reported accordingly to the War Department. A number of cast iron service guns have been consequently placed at Capt. Palliser's disposal, to be bored and altered in accordance with his principle, and to be similarly tested at the Arsenal proof butt at Woolwich. Capt. Palliser, it appears, has for many years applied himself to the study of cast iron ordnance. His plan consists in removing a portion of the existing metal from the interior of the gun and inserting a combination of steel and iron tubes in such a manner as to relieve the outer cast iron case from all strain, whereby the gun acquires all the advantages of the present wrought iron ordnance. Capt. Palliser, it is understood, maintains the principle that steel and wrought iron tubes of limited thickness can be so inserted into cast iron skins or outer portions of the existing service guns as to relieve the structure from all strain, and that only a small portion of the gun is required to resist explosion, and the remaining portion being useful merely to prevent recoil. Several guns are being prepared on Capt. Palliser's plan.

STEAM SHIPPING.

Testing of a Steering Screw Propeller.—On the 8th and 9th ult. a series of interesting experiments was carried on at Sheerness by order of the Admiralty to test the value of a steering screw propeller applied to the *Charger* gunboat, the invention of Mr. W. J. Curtis, C.E. The peculiarity of this screw is that a ring forming an universal, or ball and socket joint, is placed within the hollow boss of the screw, which is thereby connected with the main shaft, the centre of gravity of the screw and the centre line of the rudder intersecting the centre line of the main shaft, so that the entire weight of the screw is borne by the shaft, and by means of the tail or spindle of the screw projecting from the boss working in the rudder, whatever may be the movement of the rudder, it communicates an equal movement to the screw, which therefore becomes not only the propelling but also the guiding power of the ship. Furthermore, by this invention the retarding action of the rudder and likewise the vibration are removed, while the speed of the vessel is increased. The *Charger* gunboat, having been handed over to Mr. Curtis for the purpose of making experiments, was taken for trial at the measured mile off Maplin Sands, the result being that the mean of the runs to and fro was 8·698 knots an hour, as contrasted with 7·751 knots obtained at Portsmouth previous to the vessel being placed in Mr. Curtis's hands; showing a gain of ·531, or about half a mile, in favour of the steering screw, while the indicated horse power showed 113·30, against 145·25 obtained at Portsmouth. It was felt by those who witnessed the experiments that had the engines been in a more efficient working state the gain would have been still more considerable. On the following day a competitive trial of speed took place between the *Charger* and the *Spanker*, twin boats, having been built upon the same model and lines by the same builders, and each containing engines of 60 horse-power. The distance run was from a buoy off the *Formidable*, round the Nore Light and back, a total distance of about eight miles. In this distance the *Charger* beat the *Spanker* by 17 minutes, being 25 per cent. gain, or equivalent to about a mile and a half per hour, the whole run being made by the *Charger* in one hour and one minute. This gain is evidently obtained by avoiding the retarding effect of the rudder, as it was found that to keep the vessel in her course the helm never varied more than from 3 to 5 degrees. The full circle was made in 2 min. 40 sec., helm starboard 40 degrees, the diameter of the circle being 120ft., measured by a line paid out from the stern of the ship. The circle to port, helm 40 degrees, was made in 2 min. 30 sec., diameter the same, the length of the vessel being 115ft. By working the screw astern and putting the helm over 40 degrees, the vessel can be turned in about half the time above stated, and in a radius of only one-third its length, measuring from the screw itself. The screw can be applied in the dead wood of the ship, and lifted as in the ordinary way, so that the vessel may be governed either by the rudder or screw, or by both, at the option of the commander; also, if found necessary or desirable, the rudder may control the movement of the vessel by the momentum after the engines are stopped.

The Antwerp Steamer, the "Baron Osy," whilst coming up Limehouse Reach, at low tide, on the 3rd ult., with 100 passengers on board, struck her bottom against the remains of an old anchor, and sustained such a serious rent, that she sunk almost immediately, leaving barely time to get out the passengers and luggage.

Steam Shipbuilding on the Clyde.—Messrs. Steele and Co., of Greenock, have launched a fine screw of 2000 tons, named the *Peruvian*, for Messrs. Allan's ocean line of steamers. Messrs. Blackwood and Gordon, of Port Glasgow, have launched a screw named the *Tuskar*. She is the second vessel of the same name, and has been built—to supply the place of the last *Tuskar*, which was sold some months back to a Spanish firm—for the Clyde Shipping Company, by whom she will be employed as a consort to the *Pladda* in the Cork, Waterford, and Glasgow trade. The dimensions of the new steamer are as follows:—Length of keel, 175ft.; breadth, 24ft. 6in.; depth (moulded), 14ft. Her burden is 525 tons, builders' measurement, and she is to be propelled by a pair of direct acting trunk engines of 100 horse-power, manufactured by the builders. Mr. J. G. Lawrie, of Whiteinch, has launched the *Otago*, a screw of 850 tons, built for the Intercolonial Royal Mail Steampacket Company. The *Otago*, which is intended to carry

the mails between Sydney and New Zealand, will be propelled by direct acting engines of 750 horse-power, supplied by Messrs. Blackwood and Gordon. Her length of keel and fore-rake is 234ft. 6in.; breadth of beam, 26ft. 9in.; depth of hold, 15ft. 6in. Among trial trips may be mentioned that of the *Fergus*, lately launched by Messrs. A. Stephen and Sons, of Kelvinhaugh, which in running down the river attained a speed of nearly 20½ miles per hour. This vessel was launched in 56 days from her keel being laid; her engines are by Messrs. Aitken and Co. The *Mariani*, a screw built for the Société Accélérée d'Haiti, has also made a trial trip, at which she steamed at the rate of 12 miles per hour. She was built by Mr. T. B. Seath, of Rutherglen, and is 140ft. in length, 18ft. breadth of beam, and 10ft. deep. Her engines, which are of 50 horse-power nominal, have been supplied by Messrs. Campbell and Sons, of Glasgow.

THE "NORMANDY," new paddle-wheel steamer, built by Messrs. Ash, of Millwall, for the South-Western Railway Company, tested her machinery, which were manufactured by Mr. J. Stewart, Poplar, on the 3rd ult. During her trip to the Nore, her engines, which are of 225 nominal horse-power, were worked up to eight times that amount, or 1800 horse-power, and a speed of 17 knots per hour was obtained. Her draught of water was 8ft. 9in. forward, and 8ft. aft.

TRIAL OF THE "WO-KEE."—This fine screw steamer, built by Mr. Laing, of Sunderland, for the China and Japan trade, had her trial trip on the 9th ult., when she steamed on an average about 11 miles an hour. She was engined by Mr. John Key, Kirkcaldy; the engines of 80 horse-power, being those that were exhibited by him in the Exhibition of last year; and illustrated and described in THE ARTIZAN Exhibition Series, No. 5. Her engines averaged 86 revolutions a minute. The *Wo-Kee* is a vessel of 600 tons, builders' measurement. Her dimensions are:—Length over all, 185ft.; breadth, 26ft.; and depth, 15ft.

LAUNCHES.

LAUNCH OF AN AUSTRALIAN RIVER STEAMER.—On the 3rd ult. an iron screw steam-vessel, named the *Nutfield*, was launched from the premises of the builders, Messrs. James Ash and Co., Poplar. After the launch the vessel was removed into dock to be fitted with her machinery and boilers, previous to being forwarded to her owners in Australia, where she will be used for river passenger traffic. The *Nutfield* is 1770 tons burden, length 215ft., and breadth 25ft. 6in.

THE "WOLVERENE," to carry an armament of 21 guns, has been launched from the shipbuilding yard at Woolwich. Her keel was laid down in the spring of 1859. Her principal dimensions are—length over all, 253ft. 1in.; length between perpendiculars, 225ft.; length of keel for tonnage, 196ft.; breadth extreme, 40ft. 9in.; ditto for tonnage, 40ft. 5in.; ditto moulded, 39ft. 9in.; depth in hold, 24ft. 4in.; burthen in tons, 1703 5-94; horse-power, 400. Her draught of water (when she had about 30 tons on board) was found to be 16ft. aft., and 9ft. forward. She will be brought forward for the first-class steam reserve.

LAUNCH OF THE "EL MOUNASSIR," IRON RAM.—We noticed in THE ARTIZAN of August the launching of an iron-plated steam ram, from Messrs. Laird Bros., Birkenhead; another of these vessels, named the *El Mounassir*, which may be translated as the *Victory*, was launched by this firm on the 29th August. The length of the vessel over all is about 230ft.; beam extreme, 42ft.; depth, 19ft. 6in.; tonnage, about 1850 tons, O.R.; power of engines, 350 horse power. The model of the vessel will combine speed with good sea-going qualities. The stem is formed so that the vessel may be used as a ram, and the stern is arranged so as to afford protection to the screw and the rudder from shot or collision. The rig will be that of a barque with long lower masts of iron; the lower yards are also of iron. The cylindrical cupola towers, on Captain Cowper Cole's patent, are to be fitted, one before and the other abaft the engine-room, cased with thick armour plates. The armour plating of the sides of the vessel is 4½in. thick amidships, and rather less at the extreme ends. The plates are fitted on to a teak backing of great thickness. The deck of the vessel is also covered with iron plates.

THE "LAUREL" SCREW STEAMER, for the Glasgow and Londonderry Steam Packet Company, and intended to fill up the place of the well known *Thistle*, has been recently launched from the yard of Messrs. A. and J. Inglis, on the Clyde. Her dimensions are:—Length in keel and forerake, 185ft.; breadth moulded, 25ft.; depth moulded, 13ft.; and tonnage, 585 B.M. She will be propelled by a pair of piston-rod geared engines, the nominal horse-power being 140.

THE PADDLE STEAMER "ALEXANDRA" was launched from the dockyard of Messrs. Laird Bros., Birkenhead, on the 15th ult. The following are her dimensions:—Length between perpendiculars, 222ft. 6in.; beam, 28ft.; depth, 16ft.; tonnage, 800 tons; engines (oscillating), 320 H.P.; her paddle-wheels are on the feathering principle. The vessel has been built for the London and North-Western Railway Company, for the cattle trade between Holyhead and Dublin. She has a hurricane deck extending from the forecastle nearly as far aft as the forward sponson houses, and a deck house aft for passenger accommodation; so that the whole of the 'tween decks and lower holds are available for cattle, being fitted up with sloping stages leading down from the hatchways, for the cattle to walk into and out of the holds. The machinery, as well as the vessel, has been constructed by Messrs. Laird Brothers, and will be fitted on board in one of the docks at their works.

AT CORK A LARGE SCREW STEAMER was launched from the yard of Messrs. G. Robinson and Co., on the 14th ult. She has been built for Messrs. Malcolmson, Portlaw, and Co., and is intended to trade between London and Oporto. Her proportions are 275ft. long; breadth of beam, 31ft.; depth of hold, 18ft.; and her burthen, 1200 tons, being the largest iron steamship ever built at Cork.

THE "SNAEFELL," a steamer built by Messrs. Caird and Co. of Greenock, recently arrived at Douglas, Isle of Man, for service between that place and Liverpool. She is 225ft. in length, 26ft. beam, and draws 8ft. of water. The engines, constructed by the same firm, are of 250 horse-power. In a trial trip on the Clyde the *Snaefell* realised a speed of 17 miles per hour.

THE "HELEN SINCLAIR," a fine screw steamer, was launched on the 12th ult. from the yard of Messrs. J. Wigham and Co., Low Walker. The *Helen Sinclair* is the property of the London Chartered Gas Company, and is intended to form one of the line of screw colliers between the Tyne and London. Her dimensions are 190ft. long by 28ft. beam, and 17ft. depth of hold. Her engines will be supplied by Messrs. R. and W. Hawthorn, and will be of 90 nominal horse-power.

THE "NOLA," paddle steamer, was launched from the yard of Messrs. Caird and Co., on the Clyde, on the 12th ult. The *Nola* is of 750 tons, and measures 225ft. long, 25ft. broad, and 13½ft. deep. She will be fitted, by Messrs. Caird, with oscillating engines of 260 horse-power, with tubular boiler fitted before and abaft the engines.

THE "MARIA PIA," screw steamer of 513 tons, built by Messrs. J. Reid and Co., Port Glasgow, and belonging to the Lusitania Steam Packet Company, of Lisbon, was launched on the 12th ult. Her direct acting engines are of 120 horse-power, fitted with condensers, and will be supplied by Messrs. Macnab and Co., Shaw's Water Foundry.

TELEGRAPHIC ENGINEERING.

THE TELEGRAPH ACT.—The Act passed on the day of the prorogation to regulate the exercise of powers under special Acts for the construction and maintenance of telegraphs has been printed. It contains as many as 53 sections. Before a company proceeds to place a telegraph over, along, or across a street, not being a street in the metropolis or in a city, or a public road, or to place posts, they are to publish a notice that they have got the consent of the body having the control of the street, and leave notice at the dwelling houses, and are not to place the telegraph until after 21 days' notice, during which time objections can be made to the Board of Trade. If any person in the employ of a company wilfully or negligently omits or delays the transmission or delivery of any message, or improperly divulges to any person the purport of any message, he may for every such offence be liable to a penalty not exceeding £20. All messages on her Majesty's service are to have priority, and on the request of the Board of Trade a telegraph is by a company to be placed for the exclusive use of her Majesty. The Act further provides that in case of an emergency telegraphs may be taken possession of for her Majesty's service by a warrant from the Secretary of State. The warrant is only to be in force one week, but successive warrants may be issued. The Treasury in such case is to pay the company for the loss sustained. A company may be proceeded against by the law officers of the Crown on a certificate from the Board of Trade that any provision of the Act has not been complied with, or that compliance would be for the public advantage.

THE INDIAN TELEGRAPH CABLE.—The *Kirkham*, 1061 tons registry, with about 187 miles of this cable on board, left Gravesend, on the 11th ult., for the Persian Gulf, her precise destination being Bagdad. This is the second portion that has gone out, and the remaining lengths will be conveyed in three sailing vessels and a steamer. The entire length is upwards of 1200 miles, and the weight about 5000 tons.

THE MALTA AND ALEXANDRIA CABLE.—The *Hawthorne* arrived at the supposed place of the fault of this cable, about 64 miles from Alexandria, on the 10th of August, and, after creeping for five days across the line in which the cable was laid, a fragment of the cable, about half a mile in length, was picked up in 27 fathoms. The creeping was then repeated, and an end raised, which, on testing, was found to be in communication with Bengbazi. Four more detached pieces of the cable were picked up, of about half a mile each in length, and on the 17th an end was found that was in perfect communication with Alexandria. A new piece of cable, about seven miles and a half long, was spliced in, and perfect communication restored throughout the whole line. In the short length of three miles that was actually picked up there was no less than ten faults, where the cable had been completely severed, evidently for some time. There are still about four miles of unconnected cable left at the bottom, but in what condition it is impossible to tell. Some 150 sponge-boats were found by the *Hawthorne* at work on the spot, and the inference is that their anchors cut up the cable, which at this part is a deep-sea cable of small diameter, two of the boats having been found with their anchors foul of it. The navigation and direction of the ship were entirely confided to Lieutenant Drew, who was present at the laying of the cable.

THE ATLANTIC TELEGRAPH COMPANY have raised the capital they required, and the directors have selected the tender of Messrs. Glass, Elliot, and Co., who undertake to lay the cable across the Atlantic before the end of the year 1864.

THE BAGDAD TELEGRAPH of the Ottoman Government is being continued by the English Government as a line to India, and there is every probability that next year the telegraph will be in operaiton through Constantinople and Bagdad from London to Persia, Calcutta, Bombay, Madras, Ceylon, and the frontiers of China. This will be the prelude of the through line of railway from London to India. The Imperial Government, finding that the telegraphic administration had fallen into a deplorable state, has removed the director general, appointed a new one, and restored order in the management.

RAILWAYS.

CONNECTING ALDERSHOTT CAMP WITH LONDON.—The project for connecting Aldershott camp with London by a railway junction is now assuming a more definite form. According to the "preliminary prospectus" issued, the proposed line will be about 7½ miles in extent, commencing from the South-Western Railway between the Woking and Farnborough stations, proceeding by a direct route to Aldershott and thence to a point near to the Farnham station of the London and South-Western Railway Company. It can be connected also with the South-Eastern Railway at or near North Camp or Ash Church stations, whereby the whole of the military material and commissariat stores from Chatham, Woolwich, and the Tower will be conveyed direct to the Government stores by rail. The capital calculated as sufficient to complete the undertaking is £75,000, which it is proposed to raise in 7500 shares of £10 each.

TURKISH RAILWAYS.—The Smyrna and Aden Company has received the new firman for its extension to Aden, and is taking measures for its Boojah branch. The Varna Railway is successfully launched, its capital obtained, and its arrangements are steadily proceeding.

A NEW RAILWAY.—A survey, it is understood, is now proceeding for the purpose of enabling the promoters to obtain parliamentary powers in the next session for the construction of a railway from the Brighton and South-Western on Wandsworth Common to Wimbledon Common, Kingston Vale, Norbiton, Petersham, Richmond Kew, and to join the North and South-Western at Brentford. The project, it is said, is earnestly supported by the National Rifle Association.

RAILWAY ROLLING STOCK.—The gradual increase in the rolling stock of the various railway companies is very striking. Thus the Bristol and Exeter, which had, at the close of 1861, 60 locomotives and 1173 carriages of various kinds, had advanced at the close of 1862 to 64 locomotives and 1229 carriages and trucks; the Great Eastern progressed from 328 engines, and 8604 and other carriages and trucks in 1861, to 330 engines and 8650 other carriages and trucks in 1862; the Great Northern from 338 engines and 10,122 carriages and trucks in 1861, to 338 engines and 10,167 carriages and trucks in 1862; the Great Western, from 443 engines and 10,424 carriages and trucks in 1861, to 504 engines and 11,591 carriages and trucks in 1862; the Lancashire and Yorkshire, from 363 engines and 11,897 carriages and trucks in 1861, to 370 engines and 11,954 carriages and trucks in 1862; the London and North-Western, from 972 engines and 21,233 carriages and trucks in 1861, to 1031 engines and 21,391 carriages and trucks in 1862; the London and South-Western, from 177 engines and 6616 carriages and trucks in 1861, to 177 engines 4821 carriages and trucks in 1862; the London, Brighton, and South Coast, from 145 engines and 3862 carriages and trucks in 1861, to 155 engines and 3890 carriages and trucks in 1862; the London, Chatham, and Dover, from 49 engines and 576 carriages and trucks in 1861, to 78 engines and 984 carriages and trucks in 1862; the Manchester, Sheffield, and Lincolnshire, from 133 engines and 4687 carriages and trucks in 1861, to 133 engines and 4703 carriages and trucks in 1862; the Midland, from 473 engines and 11,710 carriages and trucks in 1861, to 479 engines and 11,951 carriages and trucks in 1862; the North-Eastern, from 446 engines and 24,830 carriages and trucks in 1861 to 487 engines and 29,125 carriages and trucks in 1862; the North-London, from 66 engines and 2460 carriages and trucks in 1861, to 68 engines and 2582 carriages and trucks in 1862; the South-Eastern, from 180 engines and 3990 carriages and trucks in 1861, to 201 engines and 4179 carriages and trucks in 1862; the Stockton and Darlington, from 151 engines and 17,552 carriages and trucks in 1861, to 155 engines and 17,688 carriages and trucks in 1862; and the West Midland, from 105 engines and 3743 carriages and trucks in 1861, to 115 engines and 4222 carriages and trucks in 1862. The Scotch and Irish lines have, of course, developed their rolling stock to a corresponding extent.

RAILWAY REVENUE.—In the year ending December 31st, 1859, the railways of the United Kingdom acquired £25,743,502, 10,002 miles being in operation; in 1860 the receipts rose to £27,766,622, the number of miles at work being advanced to 10,433; in

1861 the earnings further increased to £28,565,355, the extent of effective lines being 10,865 miles; and in 1862 there was a further expansion to £29,128,558, produced by 11,551 miles. The progress effected in the last three years is £3,385,056, so that this is not a very improbable assertion. The working expenses of British railways do not appear to be proportionately reduced, the ratio to the rough receipts last year having been 49 per cent., as compared with 48 per cent. in 1861. Thus, while the profits of 1861 are returned at £14,691,296, in 1862 they only increased to £14,820,691.

The Ludgate-hill Viaduct.—The City Commission of Sewers have held a meeting, at which a design of the proposed railway viaduct across Ludgate-hill was submitted for approval by the solicitors to the London, Chatham, and Dover Railway Company, who had engaged to make the structure after a design to be sanctioned by the Commissioners. The Company propose to widen Ludgate-hill to the extent of 16ft., by setting back the houses that are on the south side of the hill, from about the Old Bailey to Bridge-street. The present width of the hill is 44ft. The alterations make it 60ft., with a carriage way 30ft. broad. The proposed viaduct would allow a clear headway of 18ft. for the carriage traffic, and have sides 8ft. high. It would be an iron structure, with a span of 60ft., and with ornamental brackets at each end, placed against the sides of the abutments, and leaving a head way for foot passengers of about 9ft. A great deal of surface ornamentation was shown on the sides, giving the appearance, at first sight, of an open perforated bridge; but it would have an interior lining to prevent the fall of burning cinders from the passing trains. Mr. Haywood, the engineer, took occasion to warn them that the structure, when erected, might fall short of the expectations formed from its appearance on paper.

RAILWAY ACCIDENTS

Accident on the West Cornwall Railway.—On August 31st, the train leaving Truro at a quarter past 7 o'clock, on arriving at Penwither's-bridge, about half a mile from the station, came in contact with a "trolly." The engine was thrown off the rails, and overturned in the centre of the bridge, which gave way. The engine tender and third-class carriage were then precipitated to the road beneath, a depth of from 16ft. to 20ft. Another third-class carriage rested upon those which had fallen, and thus checked the other carriages of the train, which at once came to a stand-still. The engine-driver was killed on the spot. The two third-class carriages were empty, and the passengers in the other carriages escaped injury.

Collision on the North-Eastern Railway.—On the evening of the 7th ult. the Parliamentary train from York to Newcastle, which is due at 10.5, ran completely through a mineral train, consisting of 25 ironstone waggons, heavily laden, which, at the moment, happened to be passing over the very dangerous point where the Stockton and Darlington and North-Eastern—two of the busiest lines for mineral traffic in the kingdom—cross each other at right angles. Behind the engine and tender of the passenger train were three or four third-class carriages, all occupied. These were thrown off the line by the force of the concussion, and although greatly crushed, fortunately preserved their perpendicular. One of the waggons was carried on the buffers of the engine a distance of several yards, and acted as a powerful break. Another was pitched end over into a ditch close by; and a third fought, as it were, in the front rank of the mineral train with the passenger train for the right of way, and so caused the injury to the carriages. Fortunately no lives were lost.

Accident on the North London Railway.—On the morning of the 12th ult. an accident occurred to a North London Railway train within a few yards of the Fenchurch-street station. The train in question was the 10.20 from Camden-road, and consisted of some ten or eleven carriages, three of which were first-class and the remainder second-class carriages of the North London line. It was due at Fenchurch-street shortly before eleven o'clock, and the pace of the train had been slackened to run into the North London compartment. Suddenly a very severe shock was felt by the passengers, and many in the foremost carriages were thrown from their seats, when it was discovered that the engine No. 2, of the composite class—that is, with the boiler and tender, &c., attached, and ordinarily in use on the North London line, had left the metals and had dashed against the walls of the viaduct, carrying a great portion of it away. The escape of both train and passengers was most fortunate, for had the engine proceeded a foot or two further it must have been precipitated over the viaduct, and in all probability have dragged one or two carriages over with it.

Collision on the Glasgow and South-Western Railway.—On the night of the 10th ult. a collision occurred between two heavily-laden luggage trains at Mauchline station. The railway between Kilmarnock and Auchinleck station is at intervals on a slight incline, and between these two stations two engines are generally employed for trains which on other parts of the line require but one. On the night mentioned a train, consisting of above 30 trucks, passed along, and on coming to Auchinleck stopped to take on more trucks. There were two guards with this train, one of whom was on one of the engines and the other in the van at the end of the train. The former uncoupled some of the waggons to admit these to be taken on, and it was the duty of the latter to put on the break at his end of the train. There is reason to believe, however, that he was asleep, and on the couplings being loosened the latter part of the train commenced to run down the incline. It ran, gathering velocity as it went, for about four miles, and was nearing Mauchline station, when it was met by another train drawn by two engines. A collision occurred, and the van of the runaway being smashed, the guard was crushed to death. The first engine of the second train was thrown on its side, the nearest waggons of the other train being thrown over it.

Accident on the Great Eastern Railway.—On the 21st ult. as the 4.5 p.m. down train from Norwich to Great Yarmouth was running between Reedham and Yarmouth, the tender of one of two engines by which it was propelled left the rails. Both the engines and the other tender and all the carriages remained on the metals, and no injury was sustained by any of the passengers, as the train was promptly brought to a stand-still. The accident occurred near the Berney Arms station.

Railway Collision between Ashton and Stalybridge.—A collision occurred about two o'clock on the afternoon of the 19th ult., between Ashton and Stalybridge, on the Manchester, Sheffield, and Lincolnshire line, by the passenger train due at Ashton at 1.55 running into a luggage train shortly after leaving Stalybridge. The luggage train was standing on the line at the time. The train was proceeding at a rapid space, and, by the force of the collision, many of the passengers received injuries more or less severe. The carriages were thrown off the line, and many of them were damaged to a considerable extent.

ACCIDENTS TO MINES, MACHINERY, &c.

Colliery Accident near Newcastle.—An accident has happened since our last, at Burradon Colliery, about six miles from Newcastle, in which pit, about three years ago, ninety men lost their lives by an explosion of fire-damp. The present accident represents in its general features that of the Hartley calamity, but without the loss of life that there occurred. About one o'clock, while the engine was working, the winding machine balance-weight became detached, came crashing down through the engine-house, smashed the machinery, and broke the two winding ropes. The two cages having thus nothing to hold them fell to the bottom, completely cutting off all communication with the men below. There were between one and two hundred men and boys down the pit at the time. Under the guidance of some who knew the workings thoroughly, they sought a passage to the shaft of Seghill Colliery, which is about three miles distant; and though constantly exposed to danger from disturbing stoppings, &c., they steadily made their way out.

Quarry Accident at Cardiff.—On the 14th ult. an accident occurred at Llandaff Stone Quarry, about two miles from Cardiff, which resulted in the death of two men and serious injuries to seven others. The quarry in question is of rather an extensive description, and supplies material for the construction of the Penarth Harbour Dock. The depth being somewhat considerable, an engine is employed to raise the blocks of stone. This engine overhanges the pit of the quarry, and is supported upon two large beams of wood. As the work was proceeding on the evening in question a more than usually large piece of stone had to be raised. The engine had raised the stone some slight distance when the beams upon which the engine rested were discovered to be giving way, but before anything could be possibly done the whole structure—beams, engine, stone work, and ruins—fell down the pit.

Accident at Auckland Park Colliery.—The scene of this accident is about one mile and a half from Bishop Auckland, and lies in close proximity to the Stockton and Darlington Railway. The colliery is the property of the Black Boy Coal Company. It appears that, in consequence of government requirements, the Messrs. Wood were engaged in sinking a new shaft about fifty yards distant from the old one, so that, in case of a similar fatality to the recent one at Hartley, or any accident to the regular mode of egress, the men would still have ample means for their release in a very short time. Although this was the principal reason for the sinking of the new shaft, it was not the only one, as it was intended to sink to the bottom or working seam; but a rich seam considerably nearer the surface was the one from which the coal had to be obtained. Four seams had already been passed, when it was found necessary to fix a tap in the tubing for the purpose of relieving it from the pressure of water to which it was subject. This tap was proposed to be fixed about 54 fathoms from the top of the shaft, and with that object a half-cradle was lowered on the 13th ult., on which were six men. They proceeded with their work until ten o'clock, when they were joined by Mr. Coulson, of Durham, the contractor, and the work then proceeded under his superintendence, when shortly afterwards, while four of the men were engaged is raising the tap to the "nozzle" or branch pipe, the cradle "canted," and they were precipitated to the bottom—a distance of 51 fathoms. The cradle righted almost instantly, and it was discovered that four of its occupants had been at once killed.

BOILER EXPLOSIONS.

Boiler Explosion at Dukinfield.—An accident took place on the 19th ult. at the boiler works of Messrs. Fernihough, Newton Moor, by which two men lost their lives. It appears that about half-past ten a number of boiler-makers were engaged in testing what is termed a balloon boiler, or wrought iron still, used at chemical works for the purpose of boiling tar. Before these boilers are sent out it is usual to see whether there are any leakages in the joints. The workmen were engaged in this duty when the over-pressure of steam suddenly blew out the bottom of the boiler.

WATER SUPPLY.

The Aberdeen New Water Works about to be constructed, will, it is calculated, supply the city with 5,000,000 gallons per day. The maximum quantity at present available is 1,200,000 gallons.

Water Works for Brecon.—At a recent meeting of the Brecon Local Board of Health, it was agreed that it was necessary to have a sufficient supply of wholesome water for the inhabitants of the town, and such supply of water be confined, preferably, if not absolutely, to the source at Rhydgoch, on or near the spot indicated by the town surveyor. It appears that the estimated cost of the works does not exceed £4600.

The Water Supply of London.—The analyses of Dr. R. Dundas Thompson of the metropolitan waters, in August, offer some points of interest and importance. There was a slight increase upon the organic and total impurity of the preceding month. Moreover, the Thames water at London-bridge, at high water, was highly charged with impurities and sea water, three experiments having yielded a mean of 232·67 degrees of total, and 26·38 degrees per gallon of organic impurity, while the amount of ammonia from the sewage was ·748 grains per gallon. One of the wells in St. Marylebone contained as much as 2·72 grains of ammonia per gallon. The following is the analysis as in the Registrar-General's returns:—

	Total impurity per Gallon.	Organic impurity per Gallon.
	Grs. or degs.	Grs. or degs.
Distilled Water	0·0	0·0
Loch Katrine Water, new Supply to Glasgow	2·35	·605
Manchester Water Supply	3·33	·680
Upper Marylebone-street Well	106·40	7·60
Thames at London-bridge	232·67	26·38
Thames' Companies.		
Chelsea	17·08	1·40
Southwark	16·40	1·44
West Middlesex	16·72	1·36
Grand Junction	16·74	1·60
Lambeth	17·20	1·72
Other Companies.		
East London	17·52	1·66
New River	16·00	1·20
Kent	26·16	3·68

The following is the reading of the table:—Loch Katrine water contains in the gallon 2·35 degrees or grains of foreign matter in solution, of which ·605 degrees or grains are of vegetable or animal origin.

GAS SUPPLY.

The Cardiff Gas Light and Coke Company have further reduced their price of gas 3*d.* per 1000 cubic feet, and have declared their usual dividend. The price is now 3*s.* 3*d.* to small consumers.

The Liverpool United Gas-light Company have declared a dividend of 5 per cent. for the past half-year on the consolidated stock of the company. After complying with the demands of their Act of Parliament, and having a large net surplus, the directors have recommended a further reduction in the price of their gas, namely, to all consumers within the borough 2*d.* per 1000 cubic feet; and to all consumers in the out-townships 3*d.* per 1000 cubic feet; making the actual charge for gas in the borough 3*s.* 5*d.*, and in the out-townships 3*s.* 9*d.* per 1000 cubic feet.

City Gas.—At a recent meeting of the City Commission of Sewers, Dr. Letheby submitted a quarterly report of the illuminating power and chemical quality of the gas supplied to the city of London. The report referred to the testing of the gas in the city laboratory at Jewry Chambers, Aldgate, and it is stated that 735 examinations had been made of the illuminating power of the gas during the quarter, the result of which was as follows:—

Illuminating Power in Standard Candles.

	Maximum.	Minimum.	Average.
Great Central Company	16·05	12·14	14·15
Chartered Company	14·65	10·79	13·03
City Company	16·26	8·50	13·78

From this it appears that the illuminating power of each company's gas had been generally very good. In the case of the City Company's gas, when the illuminating power fell to 8·50, it was caused by the unavoidable access of air to the gas, while the main was being laid in the neighbourhood. The chemical quality of the gas as regards the proportion of sulphur present had not been satisfactory, for in a large majority of cases the amount of sulphur was largely in excess of the quantity authorised by Parliament. This is evident from the following sulphur in 100ft. of gas:—

	Maximum.	Minimum.	Average.
Great Central Company	28·2	12·9	18·8
Chartered Company	28·9	16·9	23·1
City Company	30·9	17·7	23·4

In 26 examinations of the Great Central 16 were above the Parliamentary proportion; in 29 of the Chartered 25 were above it, and in 27 of the City Company 23 were above it. The pressure of the gas had in each case been good, exceeding that of one inch of water. A question was then asked whether or not sulphur in coal gas was injurious to health? Dr. Letheby replied that unless the proportion was so large as to be offensive to the smell, and actually to interfere with breathing, he could not say it would be injurious to health; but as the products of the combustions of sulphur were exceedingly injurious to all textile fabrics, Parliament had considered it right to prohibit the existence of more than 20 grains of sulphur in 100 cubic feet of gas.

The Calne Gas Company have reduced the price of gas from 5*s.* 10*d.* to 5*s.* per 1000 feet, from and after the 31st December, 1863; with 5 per cent. off to consumers of 10,000 feet and upward in a quarter.

The Witham Gas Company have declared a dividend of 7½ per cent., and have reduced the price of their gas to 5*s.* per 1000 feet.

At the Wallasey Local Board Meeting the gas proceedings comprised a statement of the actual cost of the manufacture of gas by the board, showing the aggregate cost of making and supplying during the past year to be 2*s.* 8*d.* per 1000 cubic feet.

At Great Bardfield it is proposed to erect gasworks at a cost of £1000, and a limited company is being formed for that purpose.

The Portsea Island Gas Company have declared a dividend of 8 per cent., per annum.

At Machynlleth a meeting has been held, at which t was resolved to erect gasworks for the town. A company with a capital of about £2000 is being formed.

The Bury St. Edmunds Gas Company, at the 28th half-yearly meeting, declared a dividend of 10 per cent. on the old capital, and 7½ per cent. on the new.

The Eastbourne Gas Company have declared a dividend of 10 per cent., and are increasing their capital £2000, to enable them to lay down new mains when required, and to substitute larger mains in the principal thoroughfares.

The Newport Gas Company have declared a dividend of 10 per cent. per annum on the class A shares, and 7½ per cent. on the class B shares.

Reduction in the Price of Gas at Bristol.—From the first of January next, the cost of gas at Bristol is to be reduced from 3*s.* 9*d.* to 3*s.* 6*d.* per thousand feet.

DOCKS, HARBOURS, BRIDGES, &c.

Liverpool Dock and Harbour Works.—The magnitude of the dock and harbour works at Liverpool may be estimated, from a report given recently at a meeting of the dock board. In the year ending June 1863, it appears that upwards of £600,000 have been spent on both sides of the Mersey, in harbour and dock works.

New Floating Bridge between Portsmouth and Gosport.—A contract has been entered into by Messrs. Lewis and Stockwell, of Blackwall, with the directors of the Portsmouth and Gosport Floating Bridge Company for the construction of a new floating-bridge for the conveyance of passengers and vehicles to and from Portsmouth and Gosport. The new bridge will be 100ft. in length by 60ft. in breadth, with two balanced prows at either end 30ft. by 16ft., for receiving and discharging freights from the shore. Along the centre of the bridge will be erected the usual deck and engine-houses, over which will be the promenade deck. On either side of the houses will be the carriage ways of equal breadth with the prows. The engines are to be 50 horse-power, nominal, and will drive two chain wheels in the centre of the engine house, over which are passed chains nearly 2000ft. each in length, the ends of which are moored in wells with ballast weights on the beach just above high water mark at Portsmouth and Gosport; the links of the chain being each 10in. in length, 3in. wide, and of 1⅛ths iron. By crossing Portsmouth harbour by this bridge vehicles will save a *detour* between Portsmouth and Gosport of about 14 miles.

Clifton Suspension Bridge.—The half-yearly meeting of proprietors has been held. The Chairman, in moving the adoption of the report, congratulated the proprietors on the progress now being made with the works. They had received 1000 tons of chains and ironwork from Hungerford; but in order to complete the work they had had to obtain 200 tons more chains, and 300 tons more of girders and ironwork, so that what was brought from London was not more than two-thirds of the material required for the work. At the next annual meeting the bridge would be nearly completed. In reply to questions, it was stated that the bridge would be considerably stronger than the one originally designed by Mr. Brunel. It would be 30½ft. in width, having a clear space of 20ft. in the centre for the carriage-way, and two footpaths of 5ft. each railed from the carriage-way on either side.

The Paris and Dieppe Canal.—A French paper states that all the surveys and soundings for this undertaking have been completed, and that the important question of feeding the canal has been solved. The line proposed by M. Sabattié stops at Gennevilliers, near Courbevole, in the department of the Seine, where, according to the project, the great mercantile port of Paris is to be established. From Gennevilliers it takes the direction of Ile Adam, skirting the foot of St. Gratien, and, reaching Beaumont, cuts the Oise at Tiverny, passes under Mont Ataire, in the valley of Théram, and, following the right side of that valley, arrives at Beauvais, where a large basin is to be formed. From Beauvais, it enters the valley of the Avolon, by which it enters Gournay; it then follows the valley of Bray until it arrives opposite the mineral springs of Forges. There it turns to the right into the small valley which receives the waters of those springs, and finds a passage through the not very elevated table-land which blocks up that valley after the rivulet has found an issue below the old Abbey of Beaubec. It then meets the Béthune, near St. Saire, and successively arrives at Neufchâtel, Arques, and Dieppe. At the latter place it sweeps away the slaughterhouse, the demolition of which has already been ordered by the city; it skirts the parsonage and infant-school of Le Pollet, suppresses the old houses of the Rue de la Lombarderie, cuts off a small corner from the cliffs, and penetrates into the port. Hence it is seen that the point of division of the canal is the plateau lying between Forges and the Abbey of Beaubec. Here, it appears, the ground is 80 metres (240ft.) above the level of Paris; instead of tunnelling the plateau, a system of locks is proposed, which are to be fed by hydraulic machines; but from what source or reservoir these are to receive their supply has not yet been decided on. The State, it appears, has not been applied to for any subvention or guarantee of interest to the company which undertakes the work.

APPLIED CHEMISTRY.

On the Poisonous Effects of Thallium, by M. Lamy.—In my memoir on thallium, I remarked that the compounds of the new metal appeared to produce poisonous effects. I attributed in fact to these effects the pains principally in the lower extremities, and accompanied with extreme lassitude, from which I suffered in the course of my labours. The facts I communicate to the Academy leave no doubt of the poisonous nature of the compounds of thallium, and I hasten to publish them, in order to call the attention of toxicologists and therapeutists to the subject. I dissolved five grammes of pure sulphate of thallium in some milk in order to administer it to two puppies; but after having tasted the liquid the animals refused to touch it again. The next day, in the afternoon, the door of the kennel was left open by a servant without my knowledge, and all the milk disappeared, having no doubt been eaten, as the sequel will show, by two hens, six ducks, and a middle-sized bitch. Some hours after the milk had disappeared the bitch became dull, uneasy, and refused to take her usual meal. In the night she was seized with acute griping pains, which caused her to howl incessantly. In the morning the pains had subsided neither in intensity nor frequency. The poor animal refused all drink and nourishment; the expression of her face was changed; her body was drawn up; her flanks were flattened; her breathing was oppressed, and there was abundant salivation. The hind limbs were at first convulsed, and afterwards, by degrees, became paralysed. The seat of pain was evidently the intestines, for she was calmed momentarily by pressure and friction on the belly. Under the preconceived idea that thallium is so small a dose could not produce such poisonous effects, I did not dream of having iodine of potassium administered as an antidote. The pains did not appear to lessen in the course of the day. The next day the paralysis had made progress; the animal was in a state of complete prostration; she was sensible, however, and seemed pleased when I went near her. The following day she died, sixty-four hours after taking the poison. During the illness she was not observed to vomit or be purged. In the evening we found one hen and six ducks dead or dying. In the birds which were still living we remarked more or less complete paralysis of the lower extremities. Lastly, the two puppies, who had only tasted a very small quantity of the poisoned milk, became dull, and seemed very fatigued; soon after they were seized with convulsive tremblings, and could with difficulty keep on their hind legs; then acute pains came on, and they died four days after taking the poison, notwithstanding the efforts made to save them. On making a post-mortem examination of these different animals, we were surprised to find neither lesion nor sign of serious inflammation. The gall-bladder of the bitch alone was distended, and in some of the ducks various serous membranes, particularly that of the liver, had a whitish granulated appearance. Spectrum analysis promptly revealed the nature of the poison. On examining small pieces of different organs with the spectroscope, I immediately recognised thallium by its characteristic, sharply-defined green line. The intestines and their contents contained the metal in greater abundance than the muscular flesh and the bones; the serous membrane of the liver more than the substance of that organ. A tooth gave no evidence of the presence of thallium. Eight days after this accident, which had deprived me of a beautiful sporting dog, and most of my poultry, I remarked that a second hen was dull; her wings drooped, and it was with difficulty she kept herself on her feet; and, curious to see, when she attempted to eat her neck did not seem long enough; when she pecked her beak could not reach the food. She languished in this state three days, when I had her killed. I was able to prove the presence of thallium in her intestines, although in very minute quantity; in other organs I did not remark a trace. Thus eleven animals—two hens, six ducks, two puppies, and a middle-sized bitch—had died from the effects of five grammes of sulphate of thallium. To be still more convinced of the energy of the poison, I gave one deci-gramme only to a third puppy, and this animal also died forty hours after having taken the poison. From the preceding facts it results that sulphate of thallium is an energetic poison, and that the two principal symptoms it produces are, in the first place, pain in the intestines, manifested by violent griping, and, in the second place, trembling, succeeded by more or less paralysis of the lower extremities. Perhaps I may add constipation, retraction and depression of the belly, and an absolute want of appetite to the above-mentioned symptoms, but I confine myself to those which most struck me. I shall remark besides the analogy of these symptoms to those produced by lead. The foregoing facts deserve the attention of physicians and physiologists. The salts of thallium, the sulphate, and particularly the nitrate, are remarkably soluble; they have but little taste, and may consequently be easily administered. But, at the same time, no poison can so easily be discovered; and, by means of the spectroscope, scientific men can with certainty tell the organs by which it is absorbed, and the channels by which it is expelled from the system. I cannot terminate this note, without remarking that spectrum analysis may render important services to physiology and particularly to toxicology.

New Process for Silvering Glass, by M. A. Martin.—Among the large number of processes for silvering, Drayton's process is the best adapted for telescope glasses; but, as this process requires great skill on the part of the operator, I have endeavoured to find some method, which, by its simplicity and sureness, might become general. After carefully studying and experimenting on all the known processes (aldehyde, sugar of milk, glucosate of lime, &c.), I have arrived at one, which, from its simplicity and the firm adherence of the layer of silver deposited, seems to fulfil all the necessary conditions. I begin by preparing:—1. A solution of 10 grammes of nitrate of silver in 100 grammes of distilled water. 2. An aqueous solution of pure ammonia, marking 13 degrees on Carter's areometer. 3. A solution of 20 grammes of pure caustic soda in 500 grammes of distilled water. 4. A solution of 25 grammes of ordinary white sugar in 200 grammes of distilled water. Into this pour 1 centimetre cube of nitric acid at 36 degrees, boil for twenty minutes, to produce the interversion of the sugar, and then make up the volume of 500 centimetres cube with distilled water, and 50 centimetres of alcohol at 36 degrees. This done, I prepare an argentiferous liquid by pouring into a flask 12 cubic centimetres of the solution of nitrate of silver (1), then 8 cubic centimetres of ammonia at 13 degrees (2), then 20 centimetres of the solution of soda (3); and lastly, make up a volume of 100 centimetres by 60 centimetres of distilled water. If the proportions have been properly observed the liquid will remain limpid, and a drop of solution of nitrate of silver will produce a permanent precipitate; then after being left quiet for twenty-four hours the solution is ready for use. Clean the surface to be silvered with a cotton plug impregnated with a few drops of nitric acid, then wash it with distilled water, drain and place it on supports on the surface of a bath, composed of the argentiferous liquid, to which has been added one-tenth or one-twelfth of the solution of sugar (4). Under the influence of diffused light the liquid becomes yellow, then brown, and after from two to five minutes the whole of the surface of the glass will be silvered; after ten or fifteen minutes it will have attained the required thickness; it must be washed first with ordinary water, then with distilled water, and stood upon its edge to dry in the air. The surface will then be covered with a light, whitish veil, easily removed by a little polishing rouge on chamois leather, leaving a brilliant surface, perfectly adapted by its physical constitution for the purposes for which it is intended.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated July 27th, 1863.

2115 T. Bonroe—Storing and holding petroleum and other oils, naphtha, and other products of distillation containing essential oils.
2116 F. Prevost—Steam engines and the mode of utilising steam.
2117 J. Clark—Break blocks for railway and other carriages.
2118 J. Ward—Diving apparatus.
2119 C. Richard—Lighting and cutting the end of cigars.
2120 W. E. Newton—Breech-loading fire arms.
2121 G. Richards—Ordnance and fire arms, and the projectiles to be used therewith.

Dated August 28th, 1863.

2122 G. Davies—Iron and steel
2123 R. Bell—Measuring apparatus for looms.
2124 J. Shaw—Cutting or reducing turnips or other roots as food for animals.
2125 R. Vickers—Steel.
2126 E. Amoorons—Separating solid from fluid fecal matters.
2127 L. A. Mulet—Shoeing of hardened indian-rubber, gutta-percha, and other improved similar materials, applicable to all domestic animals.
2128 J. Alison—Tilling land.
2129 C. Horratt—Tilling land.
2130 J. Walls—Steam boilers.

Dated August 29th, 1863.

2131 H C. Pennell—Skates.
2132 H. W. Putnam—Wringing clothes.
2133 G. Lowry—Cotton gins
2134 T. Williams — Crushing and flattening the stalks of tobacco and other substances
2135 W. Tingey—Printing carpets, piled fabrics, druggets, and other similar articles.
2136 T. Williams—Stemming and opening cotton and other fibrous materials.
2137 W. Whitworth & J. Wrigley—Furnaces of steam boilers.
2138 D Speirs, A. Boyd, & J. Kirkwood—Looms for weaving.
2139 A. Agnew—Breech-loading fire arms.
2140 P. C. P. Hoffman—Shears for cutting metal and other substances
2141 W. Weldon—Aerial navigation.
2142 A. Rowand—Evaporating fluid solutions.
2143 J. Dodge—Grinding and polishing metallic articles.
2144 L. E. C. Martin—Generating steam and gases for heating steam boilers.

Dated August 31st, 1863.

2145 G. Attock—Assistant bearing springs for locomotive engines, railway carriages, waggons, and trucks.
2146 H. E. Kramer—Printing in colours pictures or devices to be used in ornamenting porcelain, stoneware, earthenware, or any other substances where the colours can be annealed or melted or burnt in.
2147 F. A. Braendlin—Breech-loading fire arms.
2148 G. Bebbington & J. R. Hampson—Securing the ends of bands in packing bale goods
2149 B. L. Burnett—Removing the fuel from stoves or grates, and facilitating the extinguishing of fires used therein.
2150 W. E Gedge—Watch.
2151 A. V. Newton—Sewing by machinery
2152 A. V. Newton—Sawing irregular forms of wood.
2153 J. Miles—Traps for catching rats and mice, rabbits, and other animals and birds.
2154 G. H. Pettit—Preparing mica and talc in order to render them applicable to articles of wearing apparel and ornamental purposes.
2155 M. J. Roberts—Fitting axles for railway and other carriages.

Dated September 1st, 1863.

2156 J. Snider—Breech loading and other ordnance.
2157 C. & W. Shurrock—Looms for weaving.
2158 G. Russell—Apparatus for cooking, and obtaining fresh water.
2159 W. Clark—Hydraulic apparatus.
2160 P. Joyot—Fabric, and looms for manufacturing the same.
2161 J. H. Banks—Benches or desks for schools, churches, and other similar purposes.
2162 G. T. Bousfield—Illuminating gas.
2163 T. Krich—Pressing peat.
2164 H. W. Ewens—Wadding paper and felted fabrics
2165 M. Pinnar—Flexible translucent material or fabric to be used as a partial substitute for glass.

Dated September 2nd, 1863.

2166 J. Lewis—Preparing and drying clay, and bricks and tiles.
2167 R Young—Separating and elevating apparatus for grain or granular matters.
2168 R. Collier—Crinolines and crinoline fastenings.
2169 R. Sims—Reaping and mowing machines.
2170 C. H. Cottlett—Valves, taps, or cocks.
2171 E Alcan—Feeding wool and other textile and filamentous substances into carding, combing, and other machines for treating such substances.
2172 F C. P. Hoffmann—Crushing hard substances, washing ores and minerals, and separating earth and earthy matter from solid substances.

Dated September 3rd, 1863.

2173 C. Jackson—Bolts for fastening doors, windows, and shutters
2174 A. L. Durand—Nails.
2175 A. A. Beaumont—Engine for raising liquids.
2176 W. Boulton & J. Worthington—Making and inlaying encaustic tiles or other plastic articles and substances
2177 N. Bailly—Application of rolling friction to the axle boxes and journals of running shafts and axle trees of machines and vehicles for lessening the resistance to the motion.
2178 W. & T. Jolliffe, W. Graham, & H. Taylor—Paddle and other propelling wheels for navigable vessels.
2179 H. A. Bonneville—Attaching horses to carriages or other vehicles.
2180 H. A. Bonneville—Glossing and glazing all kinds of threads.
2181 A. V Newton—Cleaning and decorticating grain and seeds.
2182 J. Loebl & I. Pick—Fastening gloves.

Dated September 4th, 1863.

2183 C. Thornhill—Sewing boots, shoes, saddlery, and leather work generally.
2184 C. G. Kelvey & W. Holland—Chronometers and other time keepers.
2185 J. Hendry & W. Coutts—Furnaces.
2186 T. Fisher — Spring balances where spiral springs are used.

Dated September 5th, 1863.

2187 W. Lorberg—Gas and other substances.
2188 G. Hargreaves—Steam boilers.
2189 S. Mellbourn—Preparation of materials for the manufacture of paper.
2190 W. Norton—Laying and supporting submarine telegraph cables.
2191 T. & E. T. Mcody—Generation and production of motive power.
2192 J. Rowell—Fences.
2193 T. Smith—Waggon break.
2194 R. Smith—Paper making machinery.
2195 C. H. Aymes—Lids or covers for certain articles of hollow ware.
2196 G. B. Rennie—Floating docks and pontoons, and cleaning, painting, or repairing them

Dated September 7th, 1863.

2197 F. Mills, T. Booth, & T. Clegg—Preparing and spinning cotton
2198 J. B York—Closets.
2199 N. Singleton—Cutting hay, straw, or other similar products.
2200 H. Twelvetrees — Portable mangling and wringing apparatus.
2201 A. V. Newton—Apparatus for directing motion in right lines.
2202 S. Gerish & J. Weston—Morticing, drilling, dovetailing, and cutting wood.

Dated September 8th, 1863.

2203 L Mond—Obtaining sulphur and sulphurous acid from alkali waste.
2204 J. H. Cutler—Dress fastening.
2205 J. C. Lott—Turning over the leaves of music.
2206 W. A. Wilson & J. Smith—Furnace firegrates.
2207 J. Burch—Printing on certain and other terry and velvet pile fabrics, felted cloths, and other fabrics and materials.
2208 T. H. Baker & G. Friend—Treating excrementitious and sewage matters.
2209 R. A. Brooman — Working and preparing skins.
2210 W. Hewitt—Rudder.
2211 J. D. Juck—Shaping metals.
2212 L. Adam—Machine for mowing grass or reaping grain.

Dated September 9th, 1863.

2213 W. H. Tucker—Propelling and steering vessels.
2214 J. Lithe & J. H White—Coating for surfaces of iron, wood, and other materials.
2215 W. H. Hawkesworth—Preparing cotton and other fibrous materials for spinning.
2216 T. Naden—Raising the covers of hot water jugs, tea pots, coffee pots, and other vessels
2217 W. Glydon — Metallic tubes and hollow cylinders.
2218 J. B. York—Closets.
2219 W. E. Gedge—Paving ways or roads.
2220 E. T. Hughes—Chenille.
2221 J. Robinson—Steam boiler and other furnaces.
2223 N. Thompson—Stopping bottles, jars, and other vessels.
2224 G. T. Bousfield—Spinning and manufacturing wool, cotton, and other fibrous materials.
2225 W. Hutchinson—Steam engines.
2226 A. V. Newton—Steam engines.
2227 J. Muggs—Fountain pen.
2228 E. Oliver & G. Myers—Lowering and disengaging boats from vessels.

Dated September 10th, 1863.

2229 J. H. Wilson—Side lights for ships and other vessels
2230 T. B. Gordon—Granulating and drying gunpowder.
2231 W. W. Greener—Fire arms.
2232 R. & J. W Wright & W. Clough—Glazing and rolling press papers, pasteboard, and other paper.
2233 M. H Muir & J. M'Ilwham—Winding yarns or thread.
2234 W. Clark—Purification and disinfection of hydro-carburets and oils produced by the distillation of coal schist and boghead.
2235 J. H. Whitehead—Manufacture of felted fabrics.

Dated September 11th, 1863.

2236 J. Hartshorn & W. Redgate—Lace.
2237 W. Taylor—Iron rods.
2238 L. Desens—Bath or bathing machine adapted for deep water.
2239 T. J. Sloan—Braiding machines.
2240 J. Rhodes—Piecing machines.
2241 L. Meyer—Employing vapours, gases, and the heat derived from combustible matters.
2242 J. Dobbie—Railway and other carriages.
2243 J. D Lee & J. Crabtree—Looms.
2244 H. Chrichley—Stovegrates and kitchen ranges.
2245 M. Gerstenhoter—Roasting pyrites.

Dated September 12th, 1863.

2246 J. Crellin—Governing and stopping the flow or passage of liquids
2247 J. King—Assisting and regulating the process of fermentation.
2248 C. E. Wallis—Revolving fire-arms.
2249 E. N. Gregory—Uniting belts and lengths of wire gauze and other metal cloth.
2250 W. Clark—Revolving fire-arms.
2251 D. S. Sutherland—Blasting rocks and other materials.
2252 J A. Whipple — Supporting photographic cameras.

Dated September 14th, 1863.

2253 H. Riviere — Heating, cooling, and evaporating.
2254 W. R. Hutton—Lubricating compound.
2255 T. Bell—Distilling shale or other bituminous materials.
2256 W. E. Gedge—Safety lamps for mines.
2257 G. P. Millin—Facilitating the detachment of horses from carriages or vehicles, and the application of break power.
2258 G. W. Billings—Preparing hemp, flax, and other vegetable materials.
2259 W. Gassage—Drying or curing certain vegetable productions.

Dated September 15th, 1863.

2260 C. Hattcock—Cigar lighters and fusee matches.
2261 G. Howell—Stamping or obliterating and printing.
2262 W. Thompson—Electric telegraph apparatus.
2263 A. Borelny — Locomotives or other steam engines.

Dated September 16th, 1863.

2264 J. Fox—Planing or cutting off the sides of armour plates.
2265 A. Fleming—Cutting or finishing matting and similar fabrics.
2266 G. Lewal—Heating and warming buildings and for drying purposes generally.
2267 J. Cox—Swings.
2268 J. Rabill—Liquid compasses.
2269 A. Watson—Hinges.
2270 J. Daunatt—Cooling liquids.
2271 B. Latchford—Spur.
2272 B. J. Webber—Thrashing machines.
2273 R. Thomson—Mixed fabric, and the application thereof to covering umbrellas and parasols.
2274 E. Scott & J. Starkey—Looms.
2275 R. Harrington—Umbrellas and parasols.
2276 J. M. Tate—Hanging the lower topsail yards of ships and other sailing vessels.

Dated September 17th, 1863.

2277 J. McEwen—Combined coke and hot blast oven.
2278 Z. J. Mercier—Gas cock of elastic and continuous pressure.
2279 W. E Gedge—Instruments for ascertaining levels.
2280 J. Edwards & J. Livesey—Permanent way of railways.
2281 A. Chaplain—Propelling ships or vessels.
2282 P. Cowan—Refining sugar.
2283 F. de Wylde—Hydrated silica.
2284 R. A. Brooman—Taps.
2285 J G. Ulrich—Apparatus for railway carriages and trains in order to obtain greater safety to passengers.
2286 J. H. Johnson—Life and swimming belts.
2287 P. McLaren—Drying paper, pasteboard, and similar fabrics.
2288 C. H. Chadburn & W. J. Tristram—Ships and other vessels.
2289 J. Whitehead — Pneumatic motive power machinery.

Dated September 18th, 1863.

2290 J. Allen—Valves and cocks for steam, water, gas, and other fluids.
2291 J. Roberts & R. Naylor—Increasing, diminishing, or otherwise regulating the power and tone of organs, harmoniums, pianofortes, or other instruments with similar keys or key boards.
2292 R. D. Dwyer—Cleaning and painting or coating the bottoms of ships and other structures.
2293 G. Davies—Improvements in the manufacture of iron and steel.
2294 W. Larberg—Treatment of rags, and obtaining valuable chemical products from the animal fibre therein.
2295 I Boggs—Protecting and preserving the hulls and bottoms of ships and vessels from fouling and corrosion.
2296 A. Nelrot—New tiles.
2297 J. M. Cook — Railway carriages and other springed vehicles.
2298 R. A. Brooman—Improved threads for fishing nets.
2299 H. W. Hart—T fastenings.
2300 H. C. Huskinson—Improvements in the manufacture of buttons.
2301 A. V. Newton — Improvement in propelling vessels.
2302 W. Smith—Constructing breech-loading ordnance.
2303 W. Smith—Construction and modes of working ordnance for ships and forts, and in the means of protecting those engaged in working guns employed for such purposes.
2304 T. Small — Improvements in motive-power machinery.
2305 V. Houghton—Improvements in lamps and lamp wicks.

Dated September 19th, 1863.

2306 L. P. Chesand & H. F. Christen—Printing postage stamps, banker's bills, shares, and other similar documents.
2307 J. Buckley—Mules for spinning cotton and other fibrous substances.
2308 J. Fraser—Magazine for the safer and more economical storing of volatile oils in localities where the ground and labour are expensive.
2309 R. Couchman—Improvements in instruments for supporting, holding, or carrying parasols, bags, watches, ornaments, or other articles or appendages.
2310 C. L. Frischmann — Ginning cotton, and cleaning, opening, and preparing cotton, wool, or other fibrous substances.
2311 B. Davis & W. Bowler—Strengthening tilt hammers
2312 J. C Pooley—Improvements in brewing or preparing beverages from malt and hops.
2313 J. P. B. le Paturel—Improvements in breech-loading fire arms.
2314 I. de Angelis—Apparatus for obtaining motive power.
2315 T. Richardson, J. J. Lundy, & R. Irvine—Improvements in the extraction of oils from vegetable substances.
2316 H. Bateman—Improved construction of rotary engine.
2317 T. E. Vickers—Manufacture of cast steel tyres.
2318 J Farmer & C. Hadfield — Machinery for making bricks, tiles or slabs, and other such articles.

Dated September 21st, 1863.

2319 E F. Battier—Crinolines.
2320 W. Elsdon—Rail and road carriages, wheel tyres, and railway crossings, adapting them to such carriages
2321 W. B. Robins—Improvements in portable fire and garden engines.
2322 A. A. Downes—Improvements in artificial teeth.
2323 E. Alcan—Improvements in shears for cutting metal threads, wires, and rods, applicable also to gauging wires.
2324 E. Alcan—Improvements in condensers applicable to wool carding engines.
2325 F. A. Chatel—Burners for burning all mineral oils.
2326 R. Wallis—Loading and unloading vessels, and raising, lowering, and otherwise conveying sacks, casks, agricultural produce, and other objects from one locality to another.
2327 R. Ridley & J. G. Jones—Giving a reciprocating motion to picks and cutting tools used in getting coal and other minerals and stone.
2328 G. T. Bousfield — Improvements in power looms for weaving hair cloth and fabrics in which the weft is inserted in separate lengths of material.
2329 C. T. Burgess — Improvements in reaping machines.
2330 W. Hutchinson — Manufacturing moulded articles of india rubber.
2331 T. B Daft—Iron ships and vessels, and sheathing the same.
2332 W. A. V. Konig—Improvements in railway telegraphs and signals, and also the permanent way and carriages, for preventing railway accidents

Dated September 22nd, 1863.

2333 J. Renshaw & J. Haworth—Stretching woven fabrics
2334 G. M. de Bayelt & J. E. Pigouliete—Agglomerating fuel.
2335 P. Effertz—Making bricks, tiles, pipes, and other similar articles.
2336 C. Maitland — Improvements in mashing apparatus.
2337 J. & J. Boad—Improvements in brick and tile making machinery
2338 R. A Brooman—Compositions for preserving cheese.
2339 J. Brigham & R. Bickerton—Reaping or mowing machines.

Dated September 23rd, 1863.

2340 W. Clealnson—Improvements in the construction of pipe wrenches.
2341 J. Platt—Machinery applicable to steam and water engines.
2342 P. A. L. de Fontainemoreau — Centrifugal machines.
2343 W & J. Galloway—Lubricating journals of revolving shafts and axles.
2344 E T. Hughes—Gas condensers.
2345 W. Gibb & J. Holmud—Looms.
2346 W. T. Eley—Ball cartridges
2347 A. Colliugridge — Receptacles for oil and petroleum.
2348 J. Phillips—Levels.

Dated September 24th, 1863.

2349 W. Whit —Coating wood and other surfaces.
2350 A. E. Ragon—Machinery for mixing various ingredients to a pasty consistence.
2351 W. Woods—Implements for tilling the soil
2352 T. and W. Marshall—Metallic instruments for sewing, stitching, and closing boots.
2353 E. Drake—Gunpowder.
2354 W. G. Helsby—Mounting transparent photographic pictures.
2355 A. Firth—Furnaces for heating wheel hoops
2356 J. Webster—Utilising the waste flux from galvanising works.
2357 J Sturgeo.—Cutting and boring coal and rocks.
2358 W. Oxley—Pickers of looms.
2359 A. V. Newton—Gunpowder.
2360 H. A. Bonneville—Horse collars.
2361 H. A Bonneville—Joining leather.

FIG. 1

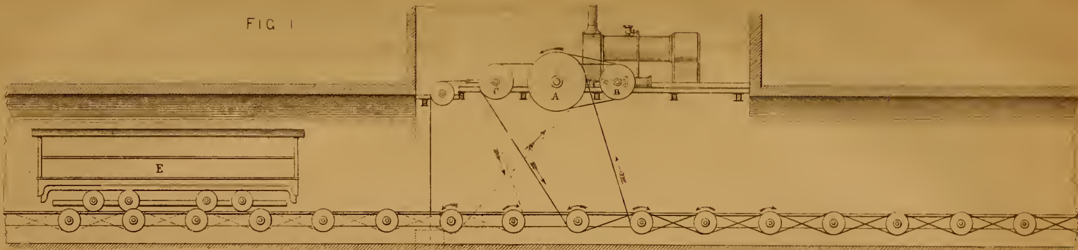
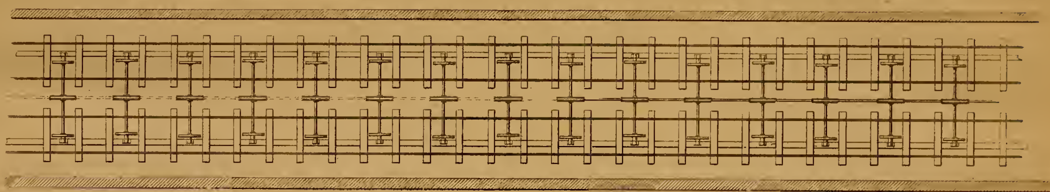


FIG. 2



PROPOSED METHOD OF

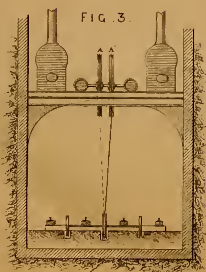
WORKING RAILWAYS BY STATIONARY ENGINES

BY

R & W. HAWTHORN NEWCASTLE-TYNE

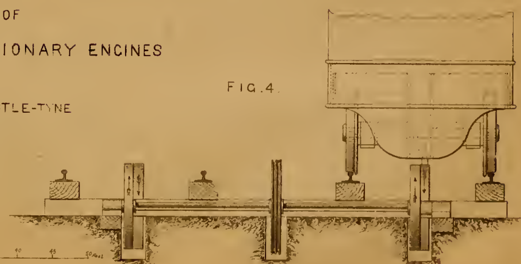
1863.

FIG. 3.



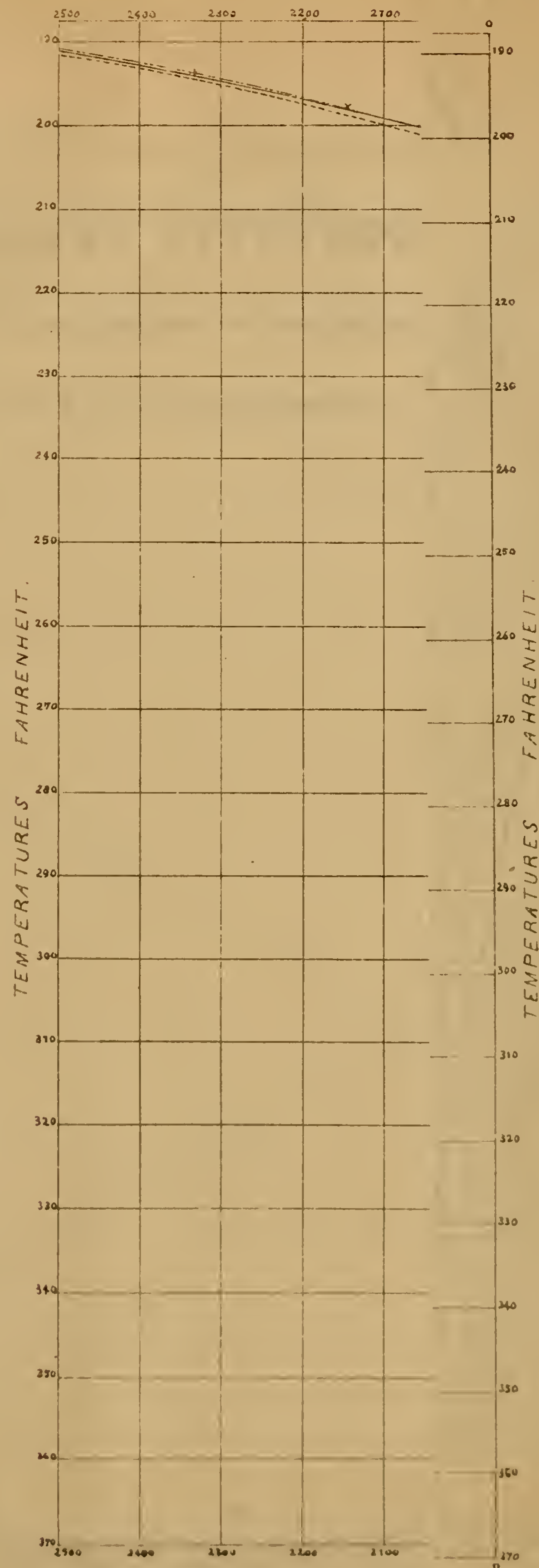
Scale to FIGS 1.2.3

FIG. 4.



SCALE ¼ INCH = 1 FOOT

W Smith C. Editor


2500
2400
2300
2200
2100
0
190
200
210
220
230
240
250
260
270
280
290
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320
330
340
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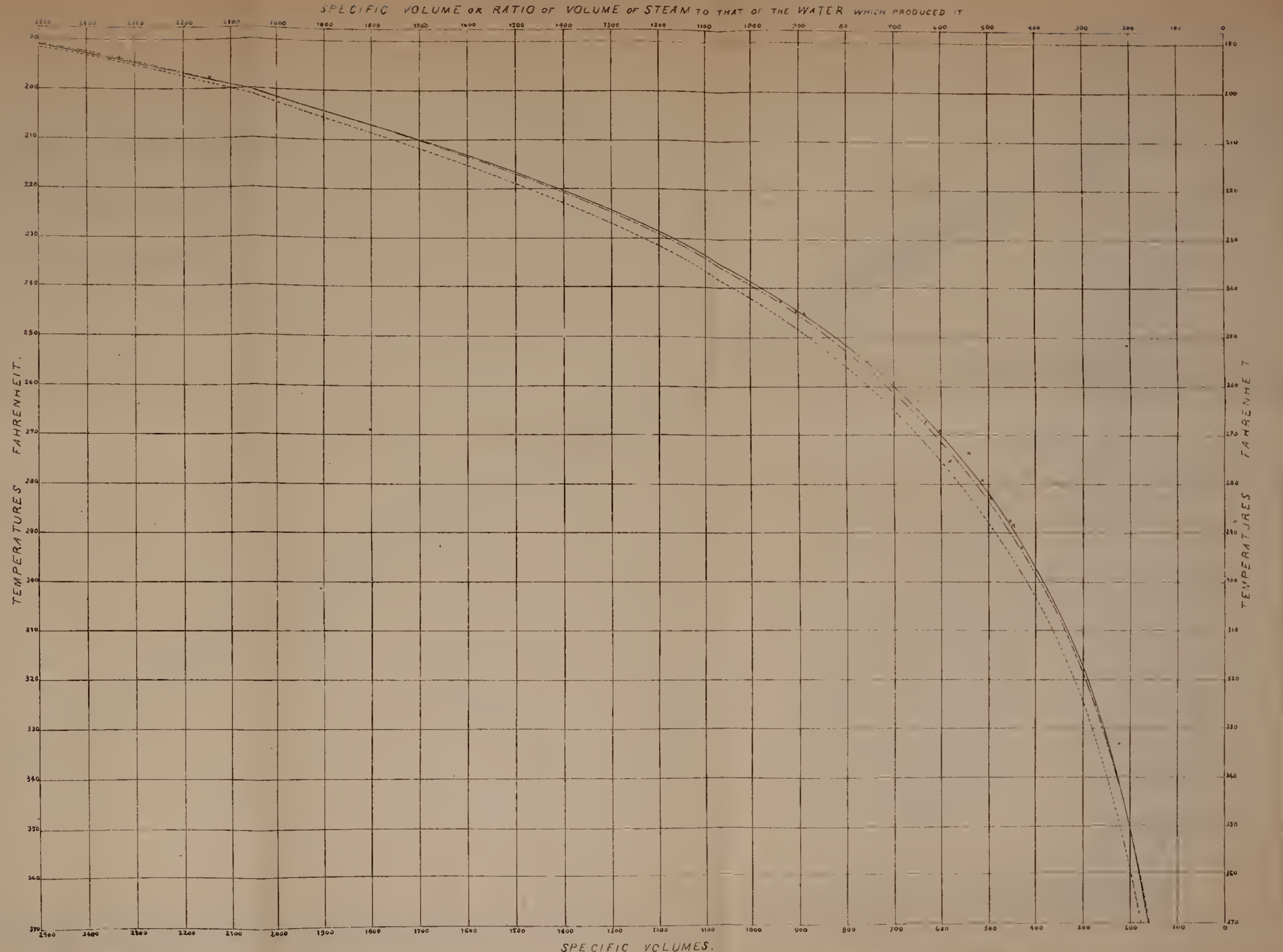
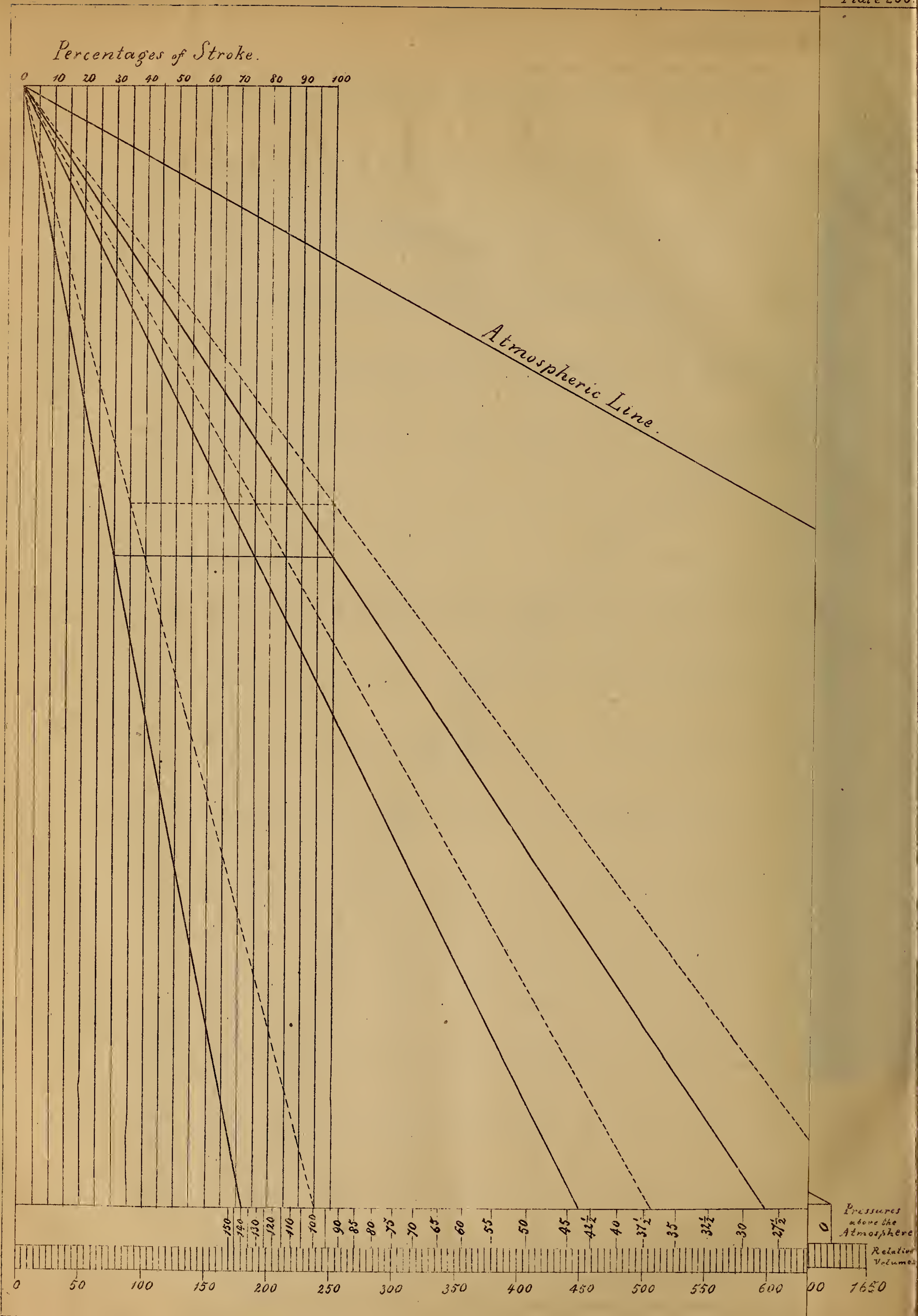
360
370
TEMPERATURES FAHRENHEIT.
TEMPERATURES FAHRENHEIT.

LOCOMOTIVE ENGINEERING.



Curve derived from Gaseous Formula .... Curve from Experimental Formula ——— Curve from M^r Rankine's formula — · — ·

Note This Plate does not include the Experiments at Low Temperatures. The Experiments a. e marked x


Percentages of Stroke.
0 10 20 30 40 50 60 70 80 90 100
Atmospheric Line.
150 140 130 120 110 100 90 85 80 75 70 65 60 55 50 45 42½ 40 37½ 35 32½ 30 27½ 0
Pressures above the Atmosphere
Relative Volumes
0 50 100 150 200 250 300 350 400 450 500 550 600 1650

THE ARTIZAN.

No. 11.—Vol. 1.—Third Series.

NOVEMBER 1st, 1863.

A CRITICAL AND HISTORICAL REVIEW OF LOCOMOTIVE ENGINEERING.

By J. J. Birckel.

(*Illustrated by Plates* 252 *and* 253.—*Continued from page* 219.)

In order to render more easy, at a single glance, the comparison between the relative volumes of steam, as we have given them in our paper in the Artizan of October last, we have prepared a diagram plate, in which the relation of temperature and specific volume is expressed by a curve, the abscissæ of which stand for increments of temperature, and the ordinates for increments of volume. The three curves shown embody respectively the results of the perfect gas theory, those obtained by Dr. Rankine's formulæ, and those obtained by Dr. Fairbairn's direct experiments; and the reader cannot but observe that the first of these curves keeps steadily aloof from the two others, while there is a strong tendency in these latter to identify themselves with each other.

Referring to Dr. Rankine's formula, it should be stated that the same was arrived at by a different process of investigation, independently and contemporaneously, by Dr. Clausius, in Germany, and that it was published almost simultaneously in the two countries in February, 1850. Dr. Rankine, however, is the first who published a complete set of tables computed from that formula; and, we think that his results have a claim to preference until further experimental evidence be obtained to show cause to the contrary, because the chances of error which may accrue from Regnault's experimental data are common both to them and to Fairbairn's, while, with these, there are the additional chances arising from the difficulties of manipulation already pointed out, such as the perfect evaporation of the whole weighed portion of water, and the simultaneous reading of the thermometer and of the column levels at the exact point of maximum temperature of saturation. As affecting, however, all practical questions relating to the steam engine, the differences between the latter named results are too small to be of any consequence.

In the application of those volumes to the calculation of the heating surface according to formula (6) of our paper of January last, it is but necessary to remember that the pressures corresponding to the volumes given in the table are absolute pressures; 15lbs., therefore, must be added to the mean actual pressure at which the steam is to work in the cylinder (which pressure, it will be remembered, is easily defined by the aid of the table given in our paper of February last), and the sum thus obtained will correspond to the value of μ required for formula (6). In plate 253 we have given a diagram, the principle of which was suggested to us by Mr. Ramsbottom, affording a ready means of finding the effective pressure, and the corresponding relative volume of steam expanding in a cylinder, at any period of the expansion. The base line represents relative volumes and actual pressures, here modified to suit Rankine's tables; the vertical lines correspond to per centages of any arbitrary stroke. The use of the diagram will be best explained and illustrated by an example; thus, let it be proposed to find the final pressure and corresponding relative volume of steam having an original pressure of 140lbs., when it is cut off at 30 per cent. of the stroke; from the point marked 140 in the base line draw a radial line to point *o* of the stroke; through the point at which it intersects the vertical corresponding to 30 per cent. of the stroke, draw a horizontal until it intersects the vertical corresponding to the end of the stroke; through this point, from point *o*, draw now a radial until it intersects the base line, and the point thus determined indicates the pressure we are in search of, namely, 28½lbs., with a relative volume of 598. In a similar manner it is found that with the same initial pressure and the same cut off, the pressure of the steam at 75 per cent. of the stroke is equal to 44¼lbs. with a relative volume of 418. By a similar mode of procedure it will be found also that steam of a 100lbs. initial pressure, cut off at 35 per cent. of the stroke, has a pressure of 37lbs. with a relative volume of 507 at 75 per cent. of the stroke, and a final pressure of 23lbs. with a relative volume of 675. This diagram may be found very useful also for defining the mean actual pressures required in formula (6), provided always, that due allowance be made in the assumption of the initial pressures, for loss due to wire drawing and condensation in the passage of the steam from the boiler to the cylinder; this loss has been assumed to amount to 23 per cent. of the pressure in the boiler in the computation of the table previously referred to.

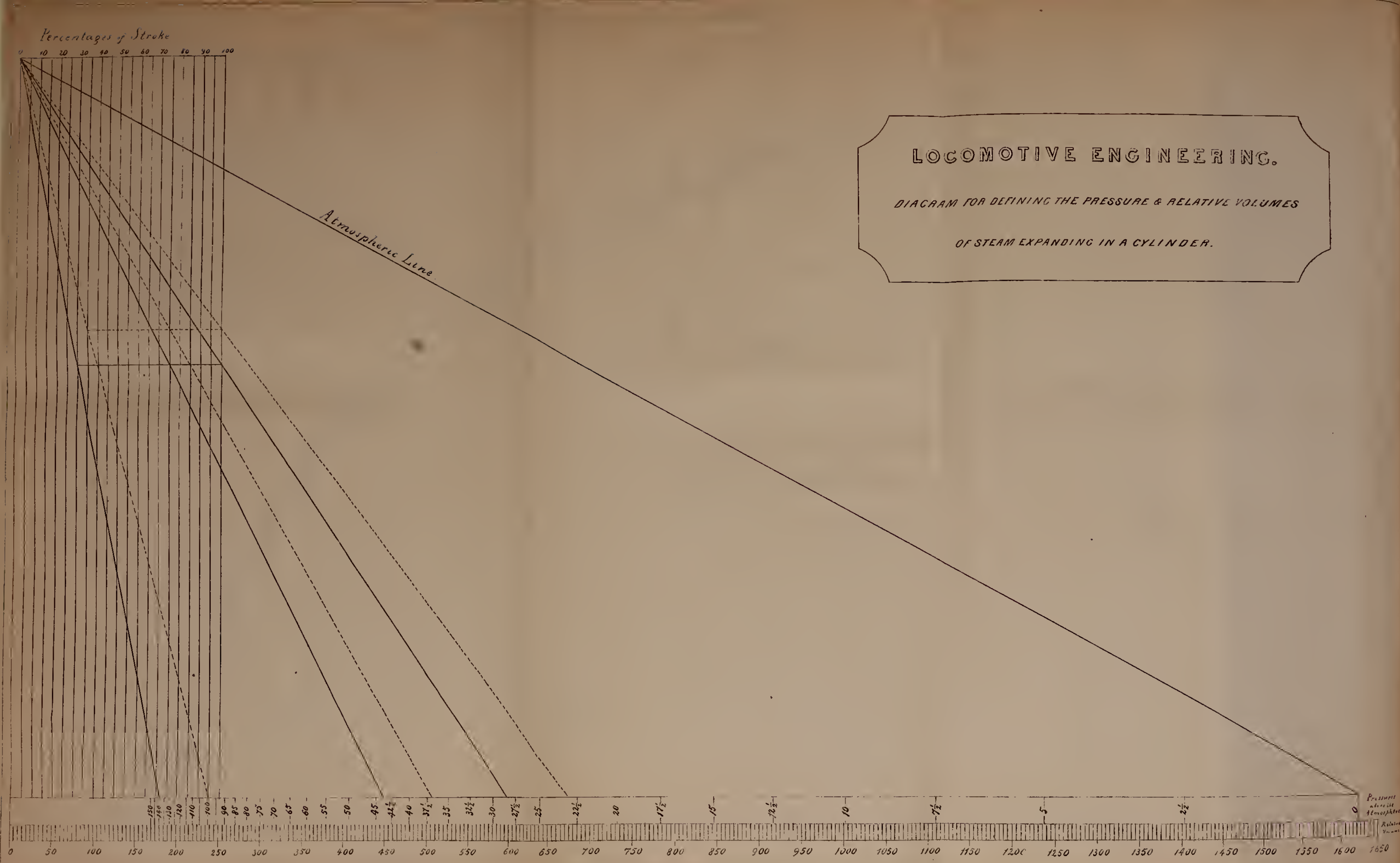
In our paper on the boiler*, when speaking of the relative evaporating capabilities of coal and coke, we have stated that the result of actual practice on the London and North-Western Railway confirms Mr. Clark's experience, that coal is capable of rendering a duty of ⅔rds of that of coke only, and in making this statement we had trusted to the information of one of the assistants at Crewe; but as soon as Mr. Ramsbottom saw the paragraph quoted, he desired us to contradict the same. In his letter to us on this subject he says that *he has long been of opinion that coal should yield a duty equal to that of coke, and that it might even yield a higher duty*. It appears also that the result of actual practice in the year 1862 upon that line, shows a ratio of 100 to 91·3, which ranges close upon equality, instead of 100 to 66, as we had stated it to be. This result becomes particularly cheering, and grows much in importance, when it is taken into consideration simultaneously with the subject of the limited duration of our coal fields,† for the calculations of geological science are almost as exact and reliable now as those of the positive sciences; and it becomes, therefore, a duty to all consumers, and especially to manufacturers and engineers in this country, independently of any considerations of present gain, not to deal wastefully with a material which is the very foundation of our industrial and commercial supremacy, and to the comforts of which, after generations have an equal claim with us.

For the conversion of coal into coke the greater part of the hydrocarbons, representing 25 per cent. of the total weight of coal, are partly required for the process of conversion, or are partly lost altogether as fuel. Considered therefore from the point of view upon which we have endeavoured to place this question, the conversion of coal into coke for the sole purpose of obtaining a fuel free from smoke is a double loss. It is an immediate loss to the consumer, who pays nearly double price for an article from which, in the production of steam, he need not necessarily obtain any better results. It is a national loss, because the period of duration of this portion of our mineral wealth is reduced in the very proportion of the waste inherent to that process. For the same reasons, also, every step made towards the perfect combustion of coal is a double gain, and every attempt towards the improvement of the steam-engine generally should be in this direction.

(*To be continued.*)

* Artizan, number for January last.

† Estimated by Sir W. G. Armstrong, in his address to the late meeting of the British Association, at 200 years, at the present rate of consumption.



W Smith, C.E. direx

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, NEWCASTLE, 1863.

ON THE CONSTRUCTION OF IRON SHIPS AND THE PROGRESS OF IRON SHIPBUILDING ON THE TYNE, WEAR, AND TEES.

By Mr. C. M. Palmer.

The first portion of Mr. Palmer's paper consisted of an account of the general principles on which iron ships are constructed; and he concluded his observations upon this part of the subject by stating that he believed that the compasses are difficult of adjustment, and that the bottoms get foul; but he hoped that in a short time science, in the promotion of which the British Association is so powerful an agent, may show us how both these difficulties may be overcome.

Mr. Palmer then proceeded to give a sketch of the progress of iron shipbuilding on the Tyne, Wear, and Tees, which formed the second, and perhaps more interesting, division of his paper.

For a very long period the district of the Tyne, Wear, and Tees has been famous for its shipping. A Committee of the House of Commons, that sat so far back as the year 1642, designated Newcastle as "the nursery for shipping;" and Defoe, writing of the Tyne in 1727, states that "they build ships here to perfection—I mean as to strength and firmness, and to bear the sea."

The history of iron shipbuilding in this district does not commence, however, until the year 1840. In March of that year, the *John Garrow*, of Liverpool, a vessel of 800 tons burthen, and the first iron ship seen in these rivers, arrived at Shields, and caused considerable excitement. A shipbuilding firm at Walker commenced to use the new material almost immediately; and, on the 23rd of September, 1842, the iron steamer *Prince Albert* glided from Walker slipway into the placid waters of the Tyne.

During the next eight or ten years very little progress was made. The vessels mostly in demand were colliers, and no one thought of applying iron in their construction; but, about the year 1850, the carriage of coals by railway began seriously to affect the sale of north country coal in the London market, and it became essential in the interest of the coal owners and others to devise some means of conveying the staple produce of this district to London in an expeditious, regular, and, at the same time, economical manner. To accomplish this object, Mr. Palmer caused an iron screw steamer to be designed in such a manner as to secure the greatest possible capacity with engines only sufficiently powerful to insure her making her voyages with regularity. This vessel (the *John Bowes*), the first screw collier, was built to carry 650 tons, and to steam about 9 miles an hour. To the success of this experiment may be attributable in a great measure the present important development of iron shipbuilding in this district, and the fact that we continue to supply so largely the London market with coal. On her first voyage, the *John Bowes* was laden with 650 tons of coals. In 48 hours she arrived in London; in 24 hours she discharged her cargo; and in 48 hours more she was again in the Tyne; so that in five days she performed successfully an amount of work that would have taken two average-sized sailing colliers upwards of a month to accomplish.

The amount of prejudice with which nautical men and persons engaged in the shipping and coal trades opposed the introduction of screw colliers was great. They argued that it would be impossible for steamers carrying 650 tons of coals, and costing about £10,000, to compete with vessels that consumed no fuel, and which, though carrying only half the quantity, cost little more than £1000, or only one-tenth the amount. Mr. Palmer was, however, confident of the result, and persisted in the development of the system. How far his views have proved correct will be borne out by the following table, which shows the number of cargoes and tons of coals imported into London by screw steamers in each year, from July 31st, 1852 (the date of entry of the first screw steamer, *John Bowes*) to June 30th, 1863:—

Year.	Cargoes.		Tons.
1852	17	making	9,483
1853	123	„	69,934
1854	345	„	199,974
1855 (Crimean war)	174	„	85,584
1856	413	„	238,597
1857	977	„	547,099
1858	1,127	„	599,527
1859 (Italian war)	899	„	544,614
1860	1,069	„	672,476
1861	1,299	„	851,991
1862	1,427	„	929,825
1863 (Half year ending June)...	714	„	463,609
			5,212,713

By this table it is seen that a total quantity of 5,212,713 tons of coals have been imported into London by screw colliers; and, in addition to this, large and increasing quantities have been taken to other ports both in this country and abroad. Since its first introduction, the screw collier has been greatly improved, and the facilities for loading and discharging very largely augmented. The screw collier *James Dixon* frequently receives 1200 tons of coals in four hours, makes her passage to London in 32 hours, there—by means of the hydraulic machinery invented by the President (Sir W. Armstrong)—discharges her cargo in ten hours, returns in 32 hours, and thus completes her voyage in 76 hours. The *James Dixon* made 57 voyages to London in one year, and in that year delivered 62,842 tons of coals, and this with a crew of only 21 persons. To accomplish this work on the old system, with sailing colliers, would have required 16 ships, and 144 hands to man them.

One of the great difficulties encountered in perfecting these vessels was in the ballasting. To dispense with the necessity of shipping shingle or chalk as ballast, many costly experiments were tried, and at length, by a system of double bottoms, the construction of which adds to the strength of the ships, the ballasting of the vessels with water was brought to a highly satisfactory result. The water is allowed to run into the spaces between the two shells as the vessels pass down the Thames; when the spaces are full, the cocks are closed, and so remain until the arrival in the Tyne, when the water is pumped out by means of an apparatus provided for the purpose. This system allows the vessel to be ballasted without loss of time at either end of her voyage, and does not impair in the slightest degree her power of carrying coals.

The introduction of the screw collier has revolutionised the coal carrying trade, and has had a most beneficial effect upon commerce generally. Besides accomplishing the purpose for which it was designed, this class of vessel has been proved capable of rendering very important services to the Royal Navy. When, in the latter part of the year 1854, information reached this country that the commissariat department of our army in the Crimea had broken down, and that the salvation of our troops depended upon a rapid despatch of supplies, it was found that screw colliers were admirably adapted for the work, and the majority of them were temporarily taken out of the coal trade and employed in the transport service. The Government admitted, on that occasion, that screw colliers had proved to be more useful and economical than any other class of vessels they had employed.

In the year following the launch of the *John Bowes*, namely, in 1853, the first iron vessel built on the Wear was loosed from its blocks. The Tees followed with great energy and considerable success, and on both those rivers, as we shall see presently, a very considerable trade in iron shipbuilding is carried on.

The first iron vessel for war purposes constructed in this district was the *Terror*, one of the large iron-cased floating batteries designed during the Russian war to operate against Cronstadt. This vessel, of 2000 tons, and 250 horse-power, carrying twenty-six 68-pounder guns, was built in three and a half months; and she would have been completed in three months had not the declaration of peace slackened the energies of the men, which up to that time had been maintained so nobly by their patriotic feelings.

It was in the building of this vessel that rolled armour-plates were first used. The demand for forged armour-plates was so great that the forges of the kingdom could not supply it, and recourse to rolling was unavoidable. At that time the largest plate mill was at Parkgate, and Messrs. Palmer accordingly employed Messrs. Beale and Co., the owners of Parkgate Works, to roll the plates required for the *Terror*. To the use of these rolled plates, however, the Admiralty opposed itself. Messrs. Palmer, feeling convinced by experiments made by them that the rolled armour plates were at least equal to the forged, invited the Admiralty to a trial of their efficiency, and built a target 9ft. square on the cellular principle, on a plan which they thought might be advantageously adopted for large vessels of war. The cells were filled with compressed cotton, which had been found by experiment to be very effectual in stopping shot. On this target was a thin teak backing, and on the teak were bolted one hammered and two rolled plates. The target was bolted on to the side of an old wooden frigate at Portsmouth, under the direction of Capt. Hewlett. The first shot fired at it missed the target, went through both sides of the frigate, and skimmed over the surface of the water for nearly a mile. The firing showed that, whilst the hammered plate split and cracked to pieces, the rolled plates were not broken, only indented, and were superior to the hammered plate in every respect. Unfortunately the target was not firmly bolted to the vessel, and it sprung at each shot, so that the bolts which held the armour plates were broken, and they fell into the sea.

A shot was then tried to test the resisting power of the compressed cotton, and it appeared to answer so well that Captain Hewlett advised a series of experiments to be tried. The Admiralty were willing, but required the targets to be provided by Messrs. Palmer at their own expense. Having already spent upwards of £1000 on experiments for the

good of the country, they declined this proposal, although Messrs. Palmer considered they had proved to the Admiralty this important fact, that the rolled plates were superior to the forged. It is, therefore, claimed for this district the honour of being the first to prove the strength and utility of rolled armour plates, since known and spoken of in Parliament as "Palmer's rolled plates."

Mr. Palmer (as the builder of the iron plated frigate *Defence*) then made a slight digression in order to express an opinion upon the class of marine architecture to which that vessel belongs, and stated that the *Defence*, although in every respect a strong ship, does not combine all the strength which, with the same weight of material, might have been obtained, and, with respect to her model, gave it as his opinion that, if she had had less rise, and more floor, and so had drawn less water, she would have steamed faster, answered the helm quicker, and have proved in all respects more manageable and convenient. The Admiralty authorities, he knew, did not agree in this view, and they are at the present moment spending a large amount of money in the national dockyards for the express purpose of building a class of vessels similar in construction. In his opinion, it was, to say the least, very questionable policy for the Admiralty to speculate in this kind of shipbuilding. Private builders exerted themselves greatly in the production of armour-plated frigates for the Government; those vessels were built in much less time than would have been consumed in the Naval dockyard, and in the matter of cost the difference must be greatly in favour of vessels built by contract. It is surprising to see the tenacity with which the Admiralty cling to wooden ships, notwithstanding the most overwhelming proofs that it is time to adopt iron exclusively.

Mr. Palmer stated that it was his desire to furnish the Association with accurate statistical details of the iron shipbuilding trade of these northern rivers, showing the quantity of iron consumed, the number of men directly employed, and the amount of tonnage launched per annum. But, unfortunately, his neighbours on the Tyne, Wear, and Tees, with a few exceptions, were too much engaged to supply him with the statistics of their respective establishments; he had, therefore, estimated the several totals from such materials, aided by personal knowledge and experience as he had been able to obtain, and the following statement is a pretty close approximation to accuracy.

Estimated amount of tonnage of iron ships launched during the year 1862 :—

	Tons.
On the Tyne	32,175
On the Wear	15,608
On the Tees	9,660

The number of men annually employed in producing this quantity of tonnage, exclusive of those engaged in the manufacture of engines, was—

On the Tyne	4,060
On the Wear	2,500
On the Tees	1,550

The quantity of iron consumed during the same period in the construction of iron ships was—

	Tons.
On the Tyne	22,540
On the Wear	9,360
On the Tees	6,760

The amount of iron tonnage at present on the stocks in this district is as follows :—

	Tons.
On the Tyne	33,000
On the Wear	19,000
On the Tees	10,660

But these statistics show us only the labour that is directly employed in the production of iron ships, and that, as we all know, is but a small proportion of the whole. It would, indeed, be difficult accurately to estimate the amount of labour that is indirectly concerned in this trade; as for instance in the manufacture of iron, the production of coals, the importation of timber, the construction of engines, and the supply of anchors, chains, sails, &c. Enough has been said, however, to prove that iron shipbuilding is one of the most important branches of industry in this great commercial and manufacturing district.

Mr. Palmer added,—I may, perhaps, be allowed to describe very briefly the operations of my own firm, which I trust will prove of some interest, as showing the extent to which one establishment may be developed. In the first place, we obtain the greater portion of our ironstone from our own mines. At a point on the coast ten miles north of Whitby, the ironstone seams crop out in the sides of the cliffs, and here we have formed the small harbour of Port Mulgrave, where vessels can ride in safety, and ship their cargoes with ease and expedition. Between the Tyne and Port Mulgrave, some of our steamers run direct, making on the average four voyages per week, whilst others of a larger class call to load stone on their return voyage from London. At Jarrow the ore is delivered to the furnaces, by means of the Armstrong hydraulic cranes, and mixed with ores from Cumberland, Devonshire, and Lincolnshire; thence it is passed to the mills, and from the mills to the shipyards. The number of men employed in these operations is upwards of 3500. The number of tons of iron consumed per annum in our yards and engine works is about 18,000 tons. The amount of tonnage launched during the year ending the 1st August was 22,000 tons. We have 15,000 tons in course of construction, and orders, spread over a period, for 40,000 tons more. Amongst these latter are steamers of upwards of 3100 tons burthen, pronounced by their owners to be "the finest and most complete merchant steamers ever built." They are intended to bring cotton from the Southern States of America, so soon as the unhappy war in that country shall cease; and they will, no doubt, be but the pioneers of others of a similar class. One of these steamers is of sufficient capacity to carry 7000 bales of cotton, and it is estimated that during one year she will bring from New Orleans to Liverpool 38,500 bales. The crew of such a vessel consists of 60 hands, and it would require five sailing vessels of 1200 tons each, employing 130 seamen, to do the same work.

A consideration of the future of the iron shipbuilding trade opens out a vast field for speculation, but the ultimate result is not difficult to anticipate. We have seen with what success sailing vessels have been superseded by steamers in the coasting and coal trades; and we know that magnificent fleets of steamers, engaged in the postal and other services, are ploughing almost every known sea. As commerce increases there will be few trades in which the employment of iron steamers will not be found of advantage. Most of the carrying trade to the Baltic and Mediterranean is already conducted in vessels of that class, and the sailing ships that cross the North Atlantic are being rapidly displaced by iron steamers. Their advantages in strength, speed, and capacity are so marked that sailing vessels of timber must give way before them. Even the Admiralty, cautious and unyielding though it be, will have to abandon its "wooden walls" in favour of the stronger and more useful material—a material, too, that lies in rich profusion beneath our feet, and has not, like timber, to be purchased of other nations. The commercial men of this country have set the Admiralty a signal example of industry and enterprise. It is they who have made the experiments and adopted the inventions that have established the maritime supremacy of this country, and it is owing to their energy that we find on every sea, in the shallow rivers of the East, and the deep broad waters of the West, English built ships of commerce, diffusing the benefits of free trade, and linking nations and tribes together in bonds of amity and peace. The true source of our national greatness is to be sought in this wonderful development of our merchant navy. Other nations are entering into friendly rivalry with us, but the larger share of the carrying trade of the world will ever be secured to that country that can produce vessels combining the largest capacity with the utmost amount of economy and expedition in construction, and that can, at the same time, navigate those vessels with the greatest degree of skill and rapidity.

In conclusion, permit me to express the proud conviction I entertain, that the mineral wealth of this district, and the skill and endurance of its workmen, whether on land or sea, will enable the locality that gave birth to an Armstrong and a Stephenson to maintain its character for maritime industry and enterprise, and to bear its full share in promoting the commercial greatness of the country.

SHORT ACCOUNT OF THE IMPROVEMENT OF THE RIVER TYNE UNDER THE PLANS NOW BEING CARRIED OUT.

When the writer was appointed engineer to the Tyne Improvement Commissioners, in 1859, certain works had been constructed and others were in progress. Of these the most important were the river walls, which had been partially constructed between Bill Point and Jarrow Slake, very much according to a plan laid down by the late Mr. Rennie, in 1813; the Northumberland Dock, made by the River Commissioners, having an area of about 50 acres, opened in 1857; the Tyne Dock, of a similar area, by the North Eastern Railway Company, opened in 1859; and the piers works at the entrance to the river, now about half completed, and then about half their present extent. The river, at that period, 1859, was much as in 1855 when its state was examined and, after a long and careful inquiry, reported on by a Royal Commission, of whom the late Mr. Brunel, Admirals Bowles and Fitzroy, Lieut. Generals Sir John Bell and Robert Armstrong, Q.C., were the members. They state in their report, in relation to the past history of the river, as follows:—

"During the last two or three centuries all the evidence would lead to the conclusion, that a very general similarity has been maintained in the state of the Tyne, notwithstanding local and partial changes. In the present century much more exact surveys have shown a similar result, namely, that notwithstanding encroachments on both banks, and many artificial works executed with various objects, the navigable state of the river has not been much altered. Whether it has been improved, and whether the works in progress are likely to improve it, or otherwise, are matters of opinion rather than fact, on which parties differ materially;

but the preponderating evidence of good authorities encourage a belief in some improvement. That this should still be only matter of opinion, needs explanation. Formerly ships sailed up and down this river, and required greater width of channel than is now wanted for steam navigation. At present the channel is less winding and deeper, but it is not so wide as it was; and although the passage for steam propelled vessels appears to be improved, the navigable condition for ships under sail, except with a fair wind, is probably to a certain extent deteriorated."

When the writer came to consider the state of the river, with the view of recommending a plan for its improvement, he found the accommodation for vessels resorting to it to be very deficient; the expenses for lighterage from the manufactories, which are principally situated in the upper part of the river, to the larger class of vessels which did not ascend above Shields' Harbour, to be large; the shifting character of the sands rendered uncertain the depth at the coal shipping places and factories on the banks; it was not unusual for vessels to be detained two months, and even longer, with their crews on board, waiting for moderate weather, with a tide sufficiently high to be able to cross the bar; deeply laden inward bound ships had a corresponding difficulty in arriving, which operated to prevent the Tyne becoming an import port; its entrance was dangerous with on-shore gales; the insand and middle ground stretched nearly across the entrance to the harbour, and in rounding it vessels, particularly if long and deep-laden, had to come nearly broadside on to the tide, when much damage was done, especially when vessels left in fleets, which was frequently the case after stormy weather, to the extent of 200 and 300 vessels in one tide, in addition to those entering. This danger became of increasing magnitude with the increasing size of vessels; the passage through Shields Harbour was very shoal, so that deep-laden vessels could not leave the docks and take the bar at high water of the same tide, which involved their staying in the harbour, after leaving the docks, till high water of the following tide, thereby incurring considerably increased expense.

Between the Northumberland dock and Newcastle, the small river steamers grounded on some of the shoals for two and three hours at low water of spring tides, and vessels of but small draft, about 13ft. to 15ft., could ascend the river to Newcastle, and these only at spring tides.

Above Newcastle the navigation was only used by keels, which were interrupted in their passage by not being able to pass over the Scotswood Shoal at high water of neap tides.

The deficiencies in the navigation were comparatively little felt in the olden time, when the Tyne was the only outlet for the comparatively small produce of the coalfields of Durham and Northumberland, in the class of vessels of about 16ft. draught, then most employed in carrying on the trade, which was principally coasting and short foreign; but when a larger and deeper draughted class of vessels came to trade to the port, to carry the greatly increased quantities of coal required to supply the steam marine of a large portion of the world, the detentions and risks became serious.

These inconveniences, and their consequent expenses, were the cause of much serious complaint, and were diverting the trade and commerce natural to the river, which the railway system made easy to do, to be developed at other places where improved provision had been made for its accommodation.

Having explained some of the commercial features of the time, when the writer had the plan for the improvement of the river under consideration, he will now give a few of its principal physical features, from observations then taken.

The rise of an average spring tide at

	Ft.	In.
Tynemouth was about	14	8
Hebburn	12	3
Below Newcastle Bridge	11	9
Above Newcastle Bridge	11	5
Scotswood	7	9
Newburn	3	11

Ryton was the limit of the tidal flow and the conservancy.

The high water of average spring tides was level between the sea and Newcastle, and rose about 12 inches higher at Newburn, but very high spring tides scarcely filled the tidal receptacle at Newcastle.

The high water of an average neap tide rises 4 to 5 inches higher at Newcastle, and about 11 inches higher at Scotswood, than at sea; it does not reach Newburn.

The rise of an average neap tide was, at

	Ft.	In.
Tynemouth	6	6
Hebburn	6	6
Below Newcastle Bridge	6	7
Above Newcastle Bridge	6	7
Scotswood	3	5

The high water of average spring tides rose higher than the high water of average neap tides, about 4 feet at Tynemouth, $3\frac{1}{2}$ feet at Newcastle, and $3\frac{1}{2}$ feet at Scotswood.

The average travel of the tidal wave between Tynemouth and Newcastle varied, but with average tides it was 8 to 12 miles per hour, and the spring tide wave between Newcastle and Newburn was about 12 to 18 miles per hour.

At that time, during average spring tides, there was $20\frac{1}{2}$ feet of water at high tide on the bar; within the bar, near to the Narrows, on the north side of the channel, a dangerous hard projection called the "stones" existed, but which had been partially removed; and immediately above, on the opposite side of the river, projected the insand and middle ground; a little further up from the north shore projected the Dortwich sand, with about 6 feet on it at low water; higher up was the Jarrow shoal, above which there were several shoals having not more than 3, 4, and 5 feet on them at low tide. Above Newcastle, at low water, the bed of the river was a great sandbank, through which the land waters drained, a great portion of the channel being not more than a few inches, and most of the remainder not more than 2 to 3 feet deep.

The places where trade was conducted and vessels lay, were mostly at the bends on the concave side of the river, where the current had scoured deep water—as between the Low Lighthouse and New Quay, North Shields, where the depth at low water was 15ft. to 21ft.; opposite South Shields, between Panash Point and Tyne Docks, 12ft. to 18ft.; the Killingworth Staiths, 10ft.; the Pelaw Staiths, 10ft. to 12ft.; the Tyne Main Staiths, 7ft. to 8ft.; Blaydon, 3ft. to 5ft., and several other such places; and Newcastle, where the deepening of the channel was due to the contraction of its width, the depth at the Quays was 5ft. to 6ft., with two short berths about 13ft.

A general comparison of the observations taken by me in 1859, with those left on record by Mr. Rennie, taken in 1813, show the high water to be about the same at both periods; but that the low water level at Newcastle had been depressed during that period about 14in. to 18in., lessening towards the sea.

In the year 1859, the number of vessels that arrived in the river was 18,878, having 3,143,857 register tonnage; and they carried altogether, including imports, exports, ballast, &c., about 5,500,000 tons; there was, in addition, carried on the river, in keels, nearly 2,000,000 tons, and about 1,000,000 tons of dredging material and factory rubbish, carried along the river to be deposited at sea.

With these data, the writer prepared a plan, by which he intended to take a comprehensive view of river improvement, and which could not fail, if successfully carried out, to benefit materially all the interests situated on the banks of the Tyne. This plan, in 1860, was submitted to the River Commissioners and approved by them, and received the sanction of Parliament in the session of 1861.

A portion of the plan sanctioned by Parliament was a dock of about 40 acres area, known by the name of the Low Lights Dock, designed with the view of affording better accommodation to the larger class of vessels, effecting a saving in towage and pilotage, and enabling that portion of the steam coal-field which is situated on the seaboard to ship the coals from it with a somewhat shorter railway lead; but, as the dock does not necessarily form a portion of the river improvement, which it is the intention of this paper to draw attention to, it will not be further alluded to.

The plan of river improvement contemplated deepening, widening, and straightening the river from the sea to the limits of the Commissioners' jurisdiction near Ryton, a distance of nearly twenty miles inland, so as to make a channel easily navigable for the largest vessels between the sea and Shields Harbour, the Docks there, and Newcastle; and for such a class of vessels in the upper part of the river as can be passed under the High Level Bridge at Newcastle; a sufficient depth of water to be carried up to the river walls, for the purposes of traders having establishments on the banks.

To give effect to these views, the plan provided for a depth at high water average spring tides of 29ft. from the sea to the docks, thence to Newcastle, 26ft., and thence to Ryton (the boundary of the Commissioners' jurisdiction), 23ft.; at average neap tides the high water depth would be about 3 to 4ft. less.

This would give a low water depth, at spring tides, of about 15ft. up to the docks, 12 to 13ft. thence to Newcastle, and above Newcastle 10 to 11ft.; at average neap tides the depth would be 3 to 4ft. more.

And to give a safe and easy navigation, at the abrupt bends, for the larger class of vessels, expected to use the river in its improved condition, it was intended to remove all projecting points that would be difficult to navigate; as, for instance, the stones, the unsand and middle ground, Whitehill Point, Bill Point, Bill Quay Point, Felling Copperas Point, Friar's Goose Point, and other smaller points; and above bridge, to cut a straight channel between Scotswood and Semington, and to remove other projections, and form a uniform navigable channel, leaving the existing channel at Blaydon to be deepened and used as a tidal basin for the accommodation of the trade located there.

The width of the river would then be, in Shield's Harbour, from 1000 to 1400ft., gradually diminishing to 850ft. at Howden, 700ft. at Hebburn, 500ft. at Newcastle, except at the narrowest part, where the quay walls are

already constructed to the limited width of 350 to 400ft., 500ft. above Newcastle Bridge, 450ft. at Scotswood, and 400ft. at the boundary at Ryton.

To admit of masted ships into the upper river, a bridge, in lieu of the existing town bridge, at Newcastle, was provided, the two centre spans, each 100ft. wide, to swing open, when it was expected that sailing vessels up to 400 tons, screw steamers up to 1000 or 1200 tons, would use the upper river, and receive their cargoes without transhipment or lighterage; and that vessels of any size, the *Great Eastern* not excepted, could be built and engined there.

The estimated capital expenditure to complete these works, with the purchase of land, &c., was £950,000.

The improvements just indicated would, when executed, give to the river a channel greatly exceeding its natural capacity, the formation of which the writer intended to accomplish and maintain by dredging; and remove the projecting points by blasting, excavation, diving, and the other usual means. The cost of maintenance of this channel he estimated to be moderate.

The piers at the entrance to the river, which were being carried out under the direction of the late Mr. Walker, he relied on for shelter when dredging in the open sea; but, from the slow progress which these works have made, he has not yet received the full benefit from this source that he expected, though, no doubt, it will be so. These works have already considerably protected the entrance to the port, and will increase in value as they approach completion by giving increased shelter to vessels entering the harbour, by dispersing and dissipating the waves after they have passed their heads, thus enabling vessels to bring up in comparatively quiet water; and the shelter so afforded will permit of the dredging machinery being applied effectually to deepen any requisite area inside of them that may be found requisite either for refuge or the ordinary operations of commerce.

The estimated expenditure to complete the piers into a depth of 30ft. at low water, as made by Mr. Walker, was £660,000; that being the depth into which the commissioners have at present resolved to carry them.

When the improvements in the river are carried out, the writer anticipates that the high water will rise about 1ft. higher at Newcastle, and 2ft. higher at Ryton, than at the sea; that the tidal column of the sea will be carried inland to the limits of the improvements; that the tidal wave will be accelerated to an average speed of 16 to 20 miles per hour; and that the great additional momentum due to the increased column of tide and greater area of receptacle, situated chiefly in the upper part of the river, and the increased sectional area of channel by allowing a more rapid discharge of the freshes, will greatly add to the scouring power of the tidal and flood waters on the river, but more especially on its sea channels.

Towards carrying out these works some progress has been made.

The stones, the insand and middle ground, the Dortwich sand, a large portion of the Whitehill Point have been removed; the general river has been deepened to such an extent, that there will be shortly, probably during the present year, the depth of water between the sea and the docks contemplated by the original plan; the river up to Newcastle has been so far improved, about 2 to 3 feet, that the small passenger steamboats are never interrupted in their passage at low water, and the passenger steamboat traffic has thus been enabled to be established. The increased depth at the same time benefited the general trade, and the upper river can be navigated by keels during all tides.

There has been already provided, or is under contract for delivery during the next three months, dredging plant, consisting of 6 dredging machines, 7 tug steamboats, 40 hoppers, 10 screw hoppers, 10 craft, repairing shops, &c., of the value of about £250,000, which is capable of raising out of the bed of the river about 2½ to 3 millions of cubic yards per annum.

Plans are in progress, and nearly completed, for the removal of Bill Point and Friar's Goose Point, and the reconstruction of Newcastle Town Bridge as an opening bridge.

The writer has hitherto every reason to be satisfied with the results attending the prosecution of these works, and does not entertain any doubt of their ultimate success. He fully expects that in about four years hence the improvements will be completed up to Newcastle, and in about four years afterwards up to the boundary at Ryton.

The only modification of the plans just described is the endeavour now being made to bring 20ft. of water at low tide from the sea into Shields Harbour, in place of 15ft., as originally intended; and the only further deviation at present contemplated is to make a portion of Shields Harbour and adjoining river 26ft. to 28ft. deep at low tide, in place of 15ft., as originally intended, in order that the very largest vessels may then be able to float there—a result which it is hoped may be accomplished during the next or following year.

Already with the improvements made there is little detention to shipping, and large vessels are frequenting the port in increasing numbers. The ease of entrance, as well as exit, combined with providing proper accommodation for cargo will, the writer anticipates, at no distant date be the means of establishing an import trade, as ships chiefly now arrive light in ballast; and he would expect that the general facilities afforded by an improved river, which in fact will become a deep and spacious harbour, nearly 20 miles long, and from 400 to 1400ft. wide, will be so valuable as to add vastly to the industrial pursuits and commerce carried on on its banks; and by no means the least expectation he ventures to indulge is, the hope that the vessels of her Majesty's navy—the Channel Fleet, if wished—may freely enter and leave our port, and be well accommodated when in it.

ON REGENERATIVE GAS FURNACES AS APPLIED TO IRON WORKS.

By C. W. SIEMENS, F.R.S., &c.

The principle of the regenerative gas furnace has already been explained to the scientific public by Professor Faraday, in a lecture delivered by him at the Royal Institution in June, 1862. Its general construction, and the history of its invention and gradual development, form, moreover, the subject of a paper which was read by me in January, 1862, before the Institution of Mechanical Engineers.

Since that period this principle of heating has been extensively applied in England, France, Germany, and other countries to glass houses, for heating gas retorts and muffles for metallurgical purposes, for melting steel, and for puddling and welding iron.

The ostensible object of this invention being to save fuel, it could hardly be expected that it would be favourably looked upon in this, the greatest coal producing district of the whole world; but experience has proved that there are other advantages resulting from its application which, in the case of puddling and working iron, are even superior in value to mere saving of fuel. The accompanying illustrations (see next page) represent a furnace for welding and working iron, and the gas generator connected with it.

The heated chamber K, is of the usual form, but, instead of a fire-place, there are four passages MN (two at each end of the chamber), leading downwards into four regenerators, or chambers LL, filled with loosely piled fire-bricks. The lower extremities of these four regenerator chambers communicate with two cast iron reversing valves.

The gas arriving from the producer through a pipe J, is directed into one or more regenerators, according to the position of the valve S, then ascends upwards, and becomes charged with heat previously deposited in the brickwork, and issues into the furnace at a certain point where it meets with a current of heated air, rising from the second regenerator to effect its combustion. The products of combustion pass away through the opposite regenerators and the reversing valves into the chimney flue.

The last named regenerators receive at this time the waste heat of the furnace, becoming heated at their upper extremity to the temperature nearly of the furnace itself, but remaining comparatively cool towards the bottom.

Every hour or half-hour the direction of the currents is reversed by a change of the valve levers; the heat, before deposited in the one pair of regenerators, is now communicated to the air and gas coming in, while the waste heat replenishes the second pair of regenerators.

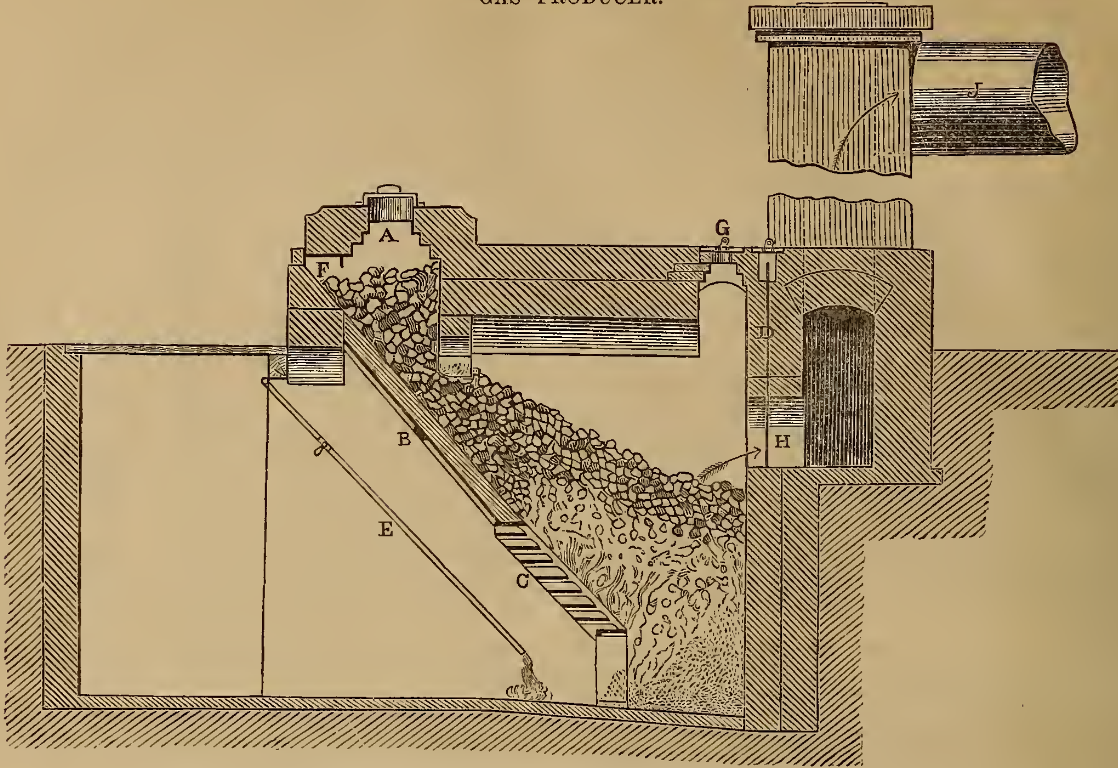
The gas producer consists of two inclined planes, upon which the fuel descends, being gradually deprived in heating of its gaseous constituents, and finally burnt to carbonic oxide by the air entering through the grate at the bottom of the inclines. Water admitted at the bottom also assists in the decomposition of the ignited coke at the bottom, converting the same into carbonic oxide and hydrogen gas.

The saving of fuel which has been effected by this arrangement amounts to from 40 to 50 per cent. In the application to reheating and puddling furnaces a saving of iron has been effected, owing to the mildness of the gas flame, of from 3 to 4 per cent. of the entire quantity put in; the iron also welds more perfectly than it does in the ordinary furnaces. Smoke is entirely obviated.

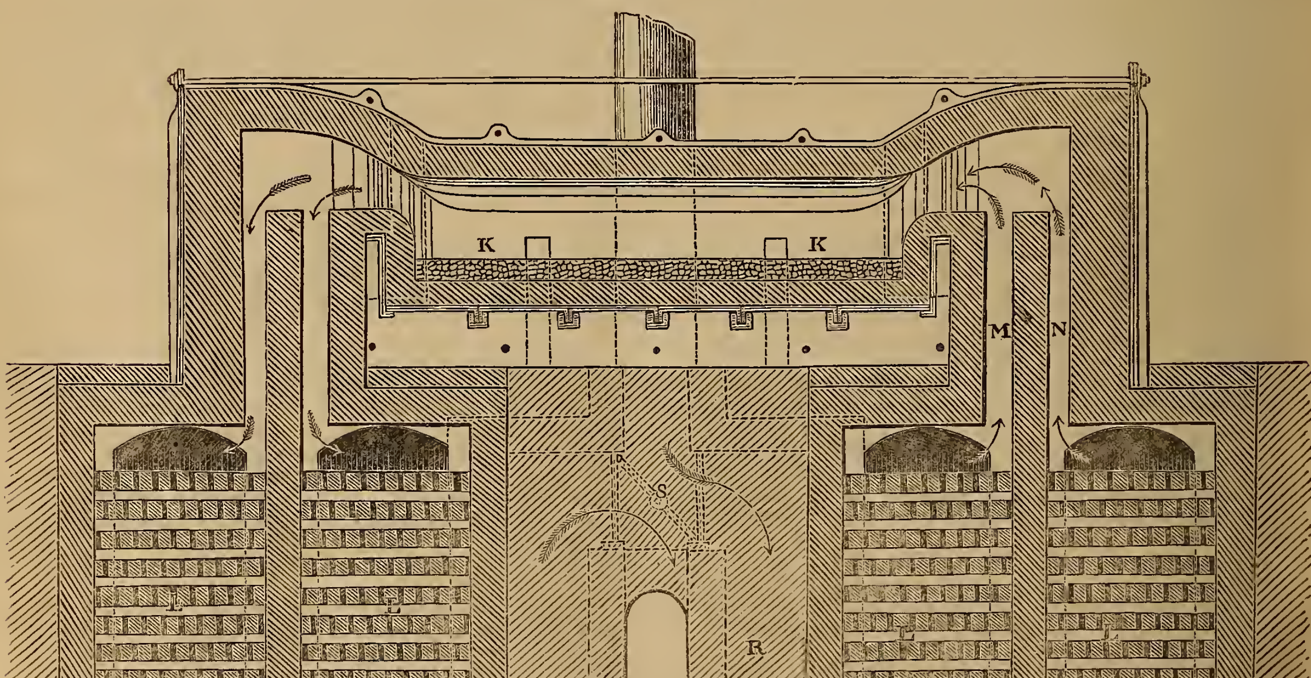
By another arrangement the regenerative principle has been applied also to coke ovens, the result being that the separation of the coke from its gaseous constituents is effected without losing the latter.

In placing the coke ovens constructed on this plan near the works where the iron is puddled and reheated, the latter operation may be entirely effected by the gas generated in the coke necessary for the blast furnace in producing the pig iron. Or the gas resulting from the regenerative coke oven may be used to heat the blast and boilers connected with the blast furnace. These latter improvements are now in course of being carried into effect on a large scale. The gas generated from these last-named producers is of a very illuminating character, and may, it is expected, be used for that purpose in preference to the hydro-carbon now manufactured by a much more expensive process.

GAS PRODUCER.



RE-HEATING FURNACE.



WORKING RAILWAYS BY STATIONARY ENGINES.

By R. and W. Hawthorn.

(*Illustrated by Plate* 251.)

The paper brought before this section is a description of a method of working a certain class of railways by means of ropes from stationary engines—specially adapted to underground railways.

A system of working railways by fixed engines and ropes has long been in use on the colliery railways around Newcastle-upon-Tyne, as well as in other districts, and a plan for the same was made the subject of a patent by Mr. Benjamin Thompson, then of Ayton Cottage, in the County of Durham, and was introduced on one or two colliery railways. It consisted of a succession of fixed engines at certain intervals from one end of the line to the other, each engine being employed to work a portion of the railway in the following manner.

The engine gave motion to two rope rolls, and the rope from one of those rolls was attached to one end, and the rope from the other roll was attached to the other end of the train. Whilst one of these rope rolls was disengaged from the engine, and allowed to run loose, the other was in gear, and the rope from it was passed along the line and round a loop sheave, then brought back and attached to the train. The engine being put in motion, the train was dragged to the furthest end of the section worked by that engine, at the same time unwinding the rope from the loose roll, and taking it with it to be afterwards employed to drag back the returning train. This was continued throughout the line, each successive engine taking up the train and carrying it over a section of the line.

This method was not a satisfactory one for the conveyance of passengers, as the rider or guard in charge had not sufficient control over the movements of the train, and there is an objection to the carriages being attached directly to the rope, and at such a distance from the motive power. Ropes have been, and are yet applied in other ways; for instance, on gravitating or descending planes, down which a loaded train passes, having the rope attached to the after end, round a sheave at the top of the incline, and thence down to the ascending train, and thus the descending loaded train draws up the ascending light train; or where the load has to ascend, a fixed engine is employed to draw it up, and the descending train takes the rope down with it. Ropes are also applied in a variety of ways, to the working of incline planes on passenger railways. Thus there is nothing new in the use of stationary engines and ropes for working railway traffic.

It will be observed that, in all the cases referred to, the rope is attached directly to the carriages.

In the proposed plan now offered to the notice of the members of the Association, the means of communicating motion to the train gives greater security, as well as the advantage of avoiding the necessity of attaching a train to the end of a rope, thus ensuring to the guard as complete control over the movements of the train, as he now has in the employment of the locomotive engine. In the new system, it may be stated, without exaggeration, that the rope drives the locomotive wheels, and each carriage carried its own railway.

It is proposed, with the ordinary construction and gauge of railway, to place in the intermediate space, between a double line of rails, a series of double grooved sheaves fixed on spindles or axles, which pass across under the rails, extending a little over the centre of each line; a plain wheel or roller is fixed upon each end of these axles, by which the motion is communicated to the train from a stationary engine or engines, placed at a convenient point of the line, by means of an endless wire or other rope passing alternately over and under the grooved sheaves to the extremity of a section of the line, where it is taken round a large loop sheave and returned to the engine now passing over each sheave, which it before passed under, and, *vice versa*, the double groove providing for the rope crossing itself without contact.

Having traversed twice along the line of sheaves, the rope goes again on to the large winding sheave of the engine, on which a sufficient number of turns are taken to ensure the requisite friction.

From this arrangement of the rope on the sheaves it will be seen that every alternate sheave runs in the same direction, and every intermediate sheave in the contrary direction; and this motion is communicated to the traction wheels or rollers, before mentioned.

It is proposed to construct the carriages for passenger lines on the principle of those used in America and on the Canadian railways, of a length of from 60 to 75ft., supported on bridges, and capable of seating from 200 to 250 passengers, each carriage to be fitted with traction bars, theso bars extending over two or more alternate traction rollers, and to be furnished with the ordinary flanged wheels for running on the rails. The traction bars, of which there are two, are placed sido by side at such a distance from each other as may be necessary to meet the requirements of the line, as to curves, &c.; and these traction bars are worked either in connection with, or independent of each other by a suitable arrangement of levers or other gearing, by which either of the bars can be raised or depressed thereby, bringing a portion of the weight of the carriage upon the traction wheels or rollers, thus giving motion to the train of carriages in either direction. Or both these bars can be raised out of contact with the traction wheels or rollers, and the train left free from all tractive force.

The traction bars will be nearly the full length of the carriage, and the traction rollers will be placed about 18ft. apart, or at the rate of 293 per mile.

The carriage made in this way is adapted for running with either end first, being provided at each end with a platform on which the driver stands to work the traction bars; and it is considered that, for ordinary traffic, one carriage will be sufficient to form a train, but two or more may be attached to each other, or the number of trains of a single carriage each may be increased to meet the requirements of the traffic.

The motion of the train can be quickly and certainly retarded or stopped by raising one bar and depressing the other in the manner of a brake, thereby reversing the direction of the driving motion.

A separate, or independent traction carriage may be used, fitted with the traction bars and gear; but it is considered that such an arrangement would in most cases only be adding a useless and unmeaning weight to the most useful portion of the train.

The present line of Underground Railway through London, from Paddington to Farringdon-street, is favourable to the use of the locomotive engine, where so much of the surface of the ground under which it passes is unoccupied by buildings, and readily admits of a good deal of open cutting and ventilation at the stations, which cannot be the case where the railway passes under the densely-populated parts of a city, as those projected in London must do. In such cases, it will be necessary to provide for working in a continuous tunnel, of perhaps three or four miles in length, in which the steam and smoke of locomotive engines would prove obnoxious to a much greater extent than is experienced on the present line, which is only partially an underground railway. As there does not appear to be any means of remedying these evils, except at a very extravagant cost, it is believed that the new system may be introduced with advantage in such cases as are above referred to, viz., railways passing under large towns, or in situations where opportunities do not occur of having openings to the surface.

The maintenance of the engines will be considerably less than with locomotives, to balance the expense of keeping in working order the sheaves, ropes, &c., which will cost more than an ordinary line.

Both calculations and experiments on the adhesion required to propel a train remove any reasonable doubt of being able, by the new system, to obtain sufficient traction force by the traction bars and pullies; and it is evidently quite feasible to increase this traction force if required. With a locomotive, a train of 15 or 20 carriages has to be drawn by an intense pressure on 6 or 8 points, and it is this which adds such a heavy item to the cost of railway maintenance. This disadvantage will be to a great extent remedied by the proposed system, the tractive force being more distributed, and, consequently, the wear and tear diminished.

Finally, if such a system as the one proposed can be introduced, free from the objections that have hitherto been considered inseparable from the use of ropes, it will greatly facilitate the construction and extension of underground railways without their present drawbacks.

In the discussion which ensued, after the members had had an opportunity of examining the working models shown in the Exchange Rooms Exhibition,

Professor Thompson (Dublin), stated, he considered that the friction of the rope on the sheaves would be excessive, from the frequent bending of the rope. He thought the present locomotive system was much better.

Mr. G. B. Bruce thought there were difficulties in the way of the practical application of the system. A difficulty would be found in getting the carriage to bear upon three surfaces fairly and equally. That was a mechanical difficulty which might be overcome. He thought the motion of the wheels underneath the carriages would cause a disagreeable motion in the carriage, and the comfort of the passengers would be interfered with. He was also afraid that in going round a sharp curve there would be a danger of the traction bar getting on the wrong wheels.

Mr. J. Jas. Turner thought the direction of the rope was merely a matter of detail, which might be changed without any great alteration of the scheme. In tunnels, curves were avoided as much as possible, and there would be no difficulty in working round a reasonable curve. It was stated in the paper, that the scheme was intended to be chiefly applicable to underground railways, or in cases where the smoke and steam from locomotives would be objectionable.

Mr. J. Fernie (Derby), said that curves were not always avoidable in tunnels, and all sorts of curves were made in them. He understood that the invention was intended to be applied, not to the ordinary railway, but to underground railways, such as had been projected in the metropolis and other large towns. He had more faith in another scheme, which had been tried to a small extent. He meant the pneumatic railway.

The President said it was not made clear by the paper, whether the traction bar was to be applied to each carriage of a train, or to one only.

Mr. Fletcher thought that, when the traction bar had passed over one wheel, it would have a tendency to drop, unless every wheel was at or about the centre, and a great shock would be given.

The President said, as he understood the scheme, the carriage was always supported on two wheels.

Mr. Abernethy, C.E., said there was another objection, viz., the using of the "journals" of the axles, which would alter their level; and the wearing of the traction bar would also bo unequal, causing the bar to bear upon one wheel and not on another.

Mr. J. F. Spencer explained that it was intended that every carriage should be a driving carriage. With regard to the difficulty of working round curves, there would certainly be no greater difficulty than existed at present. With reference to the shaking of the carriage, ho did not apprehend that, with the arrangement of springs contemplated, there would bo more than in the ordinary railway carriage. He thought that it would be found that a much greater incline could be worked up by this scheme than by the ordinary locomotive system. The object of the invention was not to supersede the ordinary railway, but for employment in tunnels, where the use of the locomotive was very objectionable.

Mr. Abernethy said that, in going round a curve, the traction bar would be a tangent to the curve, and there would be a slight motion in passing from one wheel to another.

Mr. Spencer, in reply to a question, explained how the carriages were stopped, when in motion.

Professor Thompson said that one part of his objection to the schemo was removed, by the statement that it was intended only for tunnels and not for general use. He wished to know in what respect this modo would be superior to the ordinary system of wire ropes, which was at present used in many tunnels.

Admiral Sir Edward Belcher said that, having something to do with ropes,

and being aware of the difficulty of crossing two ropes in a purchase, he thought the ropes might have a tendency to cut each other if one of them was taut and the other slack.

Mr. SPENCER, in reply to an objection as to the ability to stop the carriages, explained that, by the mechanism connected with the traction bars, the motion of the carriage would be completely under the control of the guard or driver.

Mr. ABERNETHY understood that, in order to stop the train, it would be necessary to disengage the traction bar.

Mr. SPENCER said it would. There would be a guard to every carriage, which would be built on the American principle, to carry about 240 passengers. On a short line, with constant traffic, each train would only consist of two or three carriages.

The PRESIDENT inquired if the carriages would be linked together.

Mr. SPENCER said they would, but not necessarily. In a train of carriages the first one only might be used as a traction carriage, the others being dragged by it as ordinary trains are by a locomotive. He wished it to be understood that the plan was necessarily incomplete as to many points of detail, and, therefore, he hoped that it would be charitably dealt with.

Mr. WM. HAWTHORN replied generally on the subject. He stated that, in cases where this principle was intended to be employed, he supposed that one carriage would generally be all that was necessary to constitute a train. If more were required it would only be necessary to increase the number of trains. The advantage this system had over the ordinary mode of working with wire ropes was in the perfect command of the movement of the train which the driver or guard had, by simply raising the traction bar from the sheaves, when the connection with the motive power ceased at once. The greatest amount of friction would be at the bends of the rope on the sheaves; but the friction of the axle would not be so great as might seem at first sight, and the rapid passage of the train over the wheels would prevent any tendency to heat the bearings, on which the weight would only be for a few moments.

Admiral Sir E. BELCHER,— Supposing you were ascending an incline, and the power was not sufficient, and the train commenced running back, how would you stop it?

Mr. W. HAWTHORN,—It is not intended that this scheme should be applied to inclines that could not be overcome. Supposing you were ascending an incline by a locomotive under the same circumstances, you would be in the same position.

Admiral BELCHER,—But we would have the steam power to help us.

Mr. W. HAWTHORN said there was another thing that had been alluded to—the jar that would be felt by the passengers in the carriage, by the striking of the traction bar. This, however, could only occur from some defect in the line, which would require to be kept in good repair the same as an ordinary railway. The springs which it was intended to apply would render the motion of the carriage quite easy on a good line.

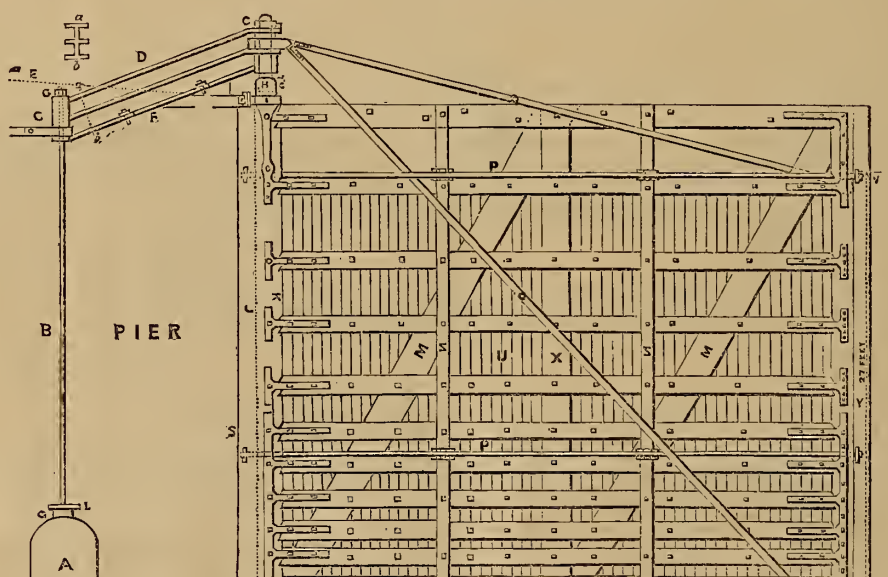
Mr. THOMAS WEBSTER said anything coming from Mr. Hawthorn must be worthy of their attention, and he trusted that the scheme might be followed up, so that they might see how far it would succeed.

The PRESIDENT said the paper had been well discussed. It was a most ingenious scheme, and had their best wishes for its success.

NEW PLAN FOR HANGING DOCK GATES.

The following is an abstract of the paper read by Mr. R. A. Peacock, of Jersey, upon this subject:—

The works of docks and harbours must necessarily be strong and durable, and therefore expensive; but any new methods of construction which are sufficiently durable and convenient, and by which expense is considerably reduced, are so much gained. He exhibited models of gates, showing how the mortices and tenons were removable. Shipping having gradually, but largely increased in dimensions during the last twenty years, it became necessary to provide wider and deeper water-ways to docks, and consequently dock gates of greater height and length. Rollers for the outer ends of the gates to travel upon, by means of tramways at the bottom of the water, were apparently thought indispensable. These tramways, being below the level of the sill of the lock, necessarily became more or less covered with mud, sand, &c., and were, as a matter of fact, so difficult to open and shut with suitable expedition, as to render necessary the very valuable, but at the same time very costly, hydraulic apparatus now in use. The question is, can gates be so constructed as to carry themselves without rollers, and so as to save a large portion of their first cost, and the whole of the heavy first cost and annual expense of hydraulic power? After mentioning a number of inconveniences incident to the present system of dock gates, he went on to say—To prevent all these inconveniences, why not treat the dock gate like an ordinary field gate? make all its parts strong in proportion to its weight, which, in the present case, is about 45 tons; make it carry itself, and so dispense with rollers and tramways. He then proceeded to describe, first, the girders and its fastenings, which are to carry our dock gate as a gate post carries its field gate, and then the suspended gate from the girder. He then remarked that this is



clearly an advantage over gates of the usual system, where the pivot is at the bottom and inaccessible on account of the weight of the gate, and also on account of the mud and the water; the bottom of the heelpost fits into a strong cast-iron shoe. He then referred to the construction of the gate, so as to secure sufficient rapidity and enable the gate to carry itself without the use of rollers, and having described the minor details of the gate, went on to show the immobility of the tenons and mortices. He stated that four lockmen could work two pairs of these gates at a cost for wages of only about £200 per annum, and the heavy cost of hydraulic power is got rid of altogether.

We may add that the dock gates referred to in this paper have been described at length in a pamphlet published by Mr. Weale, of High Holborn. This pamphlet explains the manner in which the gates are formed so as to carry themselves and dispense with rollers and tramways; it also describes the mud recesses into which the gates sweep a portion of mud every time they are opened, both which contrivances the author contends assist materially in diminishing friction. But it is thought the greatest advantage is gained by having the pivot six feet above water, so that grease can be applied at pleasure, instead of, as under the present system, having the pivots constantly immersed in mud and sand and salt water, and totally inaccessible. By these means it is sought to diminish the friction to a minimum, instead of leaving it large as it now is, and then conquering it by sheer force and at great expense. It is also proposed to make the gates of wood instead of iron, the former costing less than half as much as

the latter, and there being no material difference in the respective durability of the two substances, for while wood decays iron corrodes. The paper read by Mr. Peacock at the Newcastle meeting had for one of its principal objects to prove that the proposed wooden gates were so very rigid in their construction, that no movement of the tenons in the mortices could possibly take place. We have reason to believe that the author of the paper, being particularly desirous not to represent his proposed improvements in a more favourable light than subsequent investigation would justify—estimated at the moment that it would take four men five minutes to open or shut a pair of the gates. A calculation has, however, since been made, which is subjoined, from which it appears that four men to each gate can open them in less than one minute; and in that case they will be far cheaper and not less efficient than the present system.

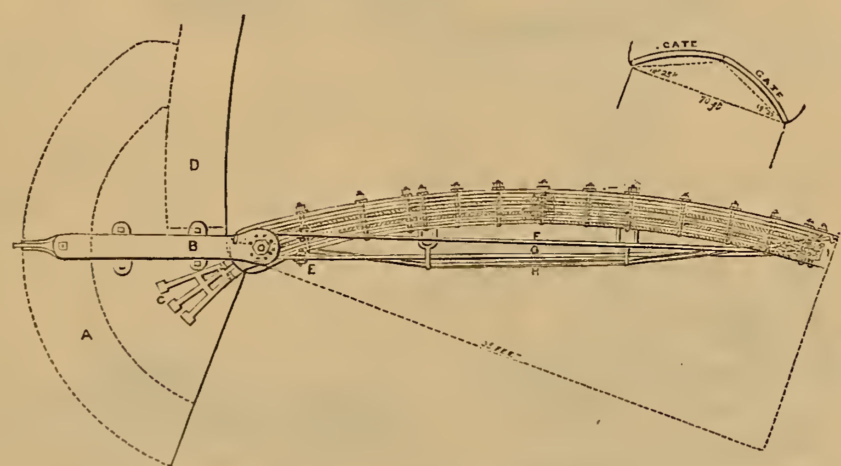
The following is a calculation of the power required to open one of the improved dock-gates, for a lock 70ft. wide and 27ft. depth of water over sill, each gate weighing 45 tons, 4 men to each gate. Pivot, brass upon cast iron, and lubricated with grease; cost of a pair of gates, £2200:—

The area of the pivot, placed 6ft. above water, is 388·77 superficial inches; by which the weight of the gate, being divided, gives a pressure on the pivot of 2·32 cwt. per square inch. And Mr. George Rennie* found this gave a friction of ·214, which amounts to 9·63 tons on the 45 tons. The centre of the pivot is 37ft. in a direct line from one end of the gate, and one foot from the other end, giving a leverage of 37 to 1. And $\frac{9{\cdot}63}{37} = {\cdot}26027$ ton, or 580lb., the power to be overcome after allowing for the leverage of the gate. And $\frac{538\text{lb.}}{4\text{ men}}$ gives 145¾lb. per man, which is a light load for a man to draw; and so the gate can be opened or shut without any machinery. As a matter of prudence, however, in case of emergency, the £2200 includes the cost of a pair of winches. With regard to time, supposing the men to travel at the rate of only one mile per hour, they will traverse the length of the arc described by the end of the gate, namely, 52ft. 4in. in 36 seconds, to which add (by estimation) 5 seconds for the impediment caused by the mud from time to time deposited. We have thus a total of 41 seconds for opening or shutting each gate by the simple strength of 4 men.

It appears that when once the heavy expense of the hydraulic and its steam engine has been incurred, a seven horse engine, occupying a very small space, may be established for £60. But there must be, no doubt, several men besides to perform the business of the lock and attend to the engine. In course of time, both the hydraulic and the iron gates, as also the wooden gates, must be renewed. The former at a very heavy, and the wooden gates at a comparatively trifling cost. This subject is certainly one well deserving of attention.

We may add that a model of these gates was exhibited in the late International Exhibition.

* See Mr. Rennie's Table on Friction, frequently reprinted in "Weale's Engineer's Pocket Book," now sold by Messrs. Lockwood and Co.



WALKER'S EQUILIBRIUM SLIDE VALVE.

A want has long been felt for some simple means of reducing the friction consequent on the working of slide valves of steam engines. Several plans have been tried for accomplishing this desirable object. The accompanying diagrams illustrate a method recently invented by Mr. E. R. Walker, of Haigh Foundry, Wigan. It appears to us to give promise of being at least as effective as any of the plans previously made use of, while there are peculiar advantages attending its employment not aimed at hitherto.

Figs. 1 and 2 are sections of a cylinder and steam chest with a short slide valve, having Mr. Walker's apparatus attached. A is part of the

FIG. 2.

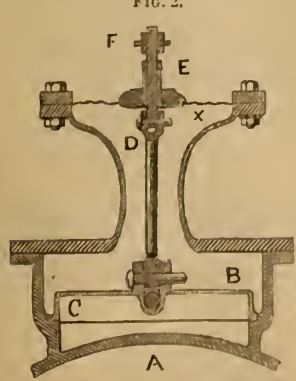
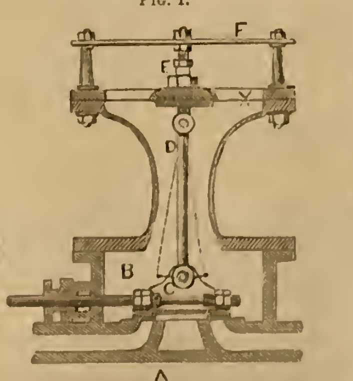


FIG. 1.



cylinder; B, the steam chest; C, the slide valve; D, a connecting link; E, a screw with nuts for altering the position of the link; F, a flat bar of spring steel; and X, a thin flexible plate of metal.

When the steam fills the chest B, it exerts a pressure in all directions, on the back of the slide valve as well as against the inside of the plate, X. The force against the plate is concentrated in the coupling rod, D, and by it buoys up the valve. When the diameter of the disc bears a certain proportion to the back of the valve the effective pressure through the rod, D, so nearly balances the opposite force that the valve can be moved over the ports with the outlay of a very small amount of power.

The flexible plate has a slight undulating motion communicated to it as the rod, D, is more or less inclined to the valve force. The extent of the motion is not allowed to exceed one-eighth of an inch, by making the rod, D, of suitable length; and as the disc is slightly extended with the hammer in the central portion before being attached to the valve, the lifting power of the disc is uniform over every part of the stroke of the valve.

The undulations of the plate have no injurious effect whatever upon it; one reason for this is, that it is evenly heated by the steam while at work,

FIG. 4.

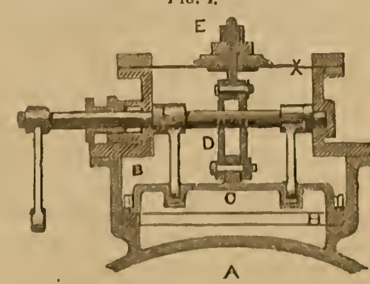
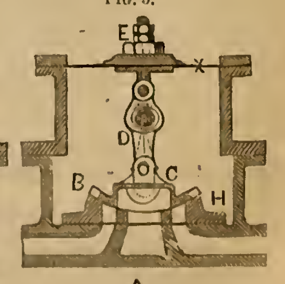


FIG. 3.



and is therefore capable of bearing greater transverse and tensile strain than at the ordinary temperature. When room cannot be spared for the length of the enlarged pipe, the disc is corrugated so as to give it greater elasticity, and the rod shortened accordingly.

Figs. 3 and 4 show a method for disposing of the undulations of the

disc, and also reducing the length of the projecting pipe. H is a loose plate, which, with the valve, is turned in the lathe to the radius of the link D. The plate H is bolted to the ordinary valve face. The valve is moved with levers, which have the same centre of motion. By this means the disc has no movement, and there is only one joint pin liable to wear, as the one next the cylinder preserves the same relative position to the valve at all points. Figs. 5 and 6 show a method of applying the disc to a balance plate G, between which and the port face the valve slides. The

Fig. 6.

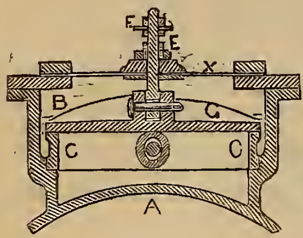
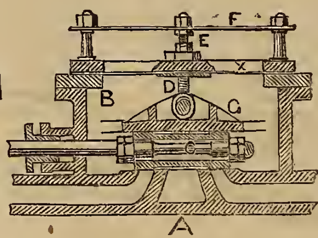


Fig. 5



valve is open thoughout, so that if the plate G were removed the steam would escape to waste down the exhaust pipe. This plan also dispenses with the motion of the disc, and further takes no more room than the ordinary arrangement. Figs. 7 and 8 show a varied application of the

Fig. 8.

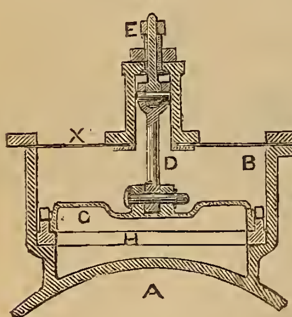
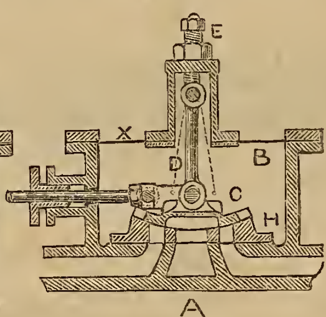


Fig. 7.



disc, having the valve worked with a spindle in the usual way. The peculiar advantage which this method possesses is that the amount of pressure on the valve can be increased or diminished at pleasure, while the engine is at work, either by means of the screw E, or the external spring; or permanently, by altering the diameter of the centre bearing washer. There are several other advantages. It is no more liable to leakage than the ordinary valve, for there is only one working face in most instances, while the equilibrium constructions, with packed rings, hollow pistons, &c., applied to the back of the valve, having two or more working faces, are difficult to maintain in an efficient state. When compared with the balance-piston, the favourite method of Bourne, and other engineers, it is found much less expensive in first cost, and the valve can be accurately balanced, for there is no friction to overcome, which demands an excess of force on the back of the valve, to prevent the piston from raising it from its face, and there is no leakage of steam, as is often observed passing through the ordinary balance-piston.

Water, finding its way into the cylinder by priming or from the condensers—that very fruitful source of accidents—can most readily escape on the least excess of internal pressure in the cylinders, as the eyes of the coupling-rods are oval to allow the valve to rise. It is well known that piston-valves, those of the Cornish construction and the American double beat valve, all require escape-valves of large size to allow water to leave the cylinder as the piston approaches the end of the stroke; here they are not necessary.

We understand that this novel method is giving uniformly satisfactory results, and is coming into general use in Lancashire, where it was first applied.

Great Western Railway of Canada.—In consequence of the high price paid for re-rolling rails in Canada (being £5 8*s*. 11*d*. per ton as compared with £3 1*s*. 8*d*. in England), a rolling mill is now in course of erection at the Hamilton Station, of sufficient power to meet the requirements of the permanent way of the line, which, with branches and sidings, now consist of 407½ miles of single track. The Company's engineer estimates the entire cost of the mill when ready for re-rolling at £17,000 sterling. It is expected that the whole will be completed by March or April next.

GOODS LOCOMOTIVE "STEIERDORF."

Constructed at the Works of the I. R. Austrian State Railway Company, Vienna.

(*Continued from page* 100.)

In The Artizan of March and May we gave copper plate engravings and woodcut illustrations, and a fully detailed general description of this locomotive. We will now proceed to describe more at length the coupling arrangement between the locomotive and tender, and the principles upon which it is based.

Referring to Fig. 14, the motive power acting upon the various axles may be resolved into a series of forces. If we call—

α the angle formed by a horizontal line and the cranks;

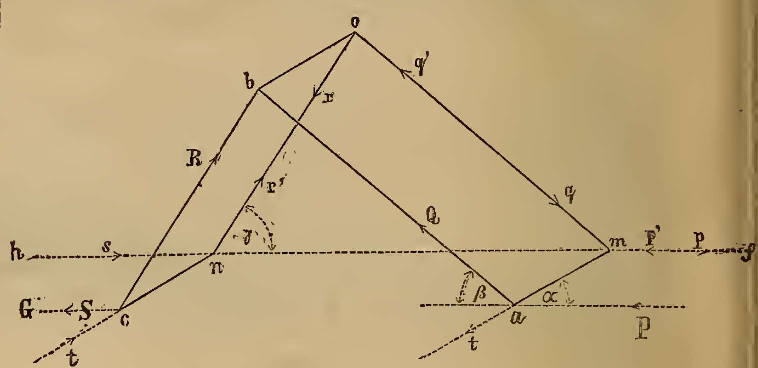
β the angle formed by a horizontal line and the rods of m;

γ the angle formed by a horizontal line and the rods of n;

P the force derived from the pressure of the piston acting on the crank axle a;

p = P, the force acting in the opposite direction, transmitted from the frame upon the axle m.

Fig. 14.



The force P may be resolved into two forces, viz., Q, acting in th direction of the coupling rod $a\ b$; and t, in the direction of the crank $a\ m$.

The force Q may be resolved again into q, acting along the guide rod $m\ o$; and p', acting horizontally in the direction $m\ f$.

We shall find then—

$$Q = \frac{P \sin \alpha}{\sin(\alpha + \beta)},\ q = Q,\ p' = P.$$

These three forces will thus stand for P. The force Q may likewise be resolved into three forces, viz.:—

R working in the direction of the draw bar $b\ c$ of the tender,

r working in the direction of the support $o\ n$,

q_1 working in the direction of the guide bar $o\ m$,

when we shall have—

$$R = \frac{Q \sin(\alpha + \beta)}{\sin(\gamma - \alpha)} = \frac{P \sin \alpha}{\sin(\gamma - \alpha)},\ r = R,\ q_1 = Q.$$

The three forces, R, r, and q_1, will then replace Q. The force R may also be resolved into three forces, viz.:—

S, acting in the direction of the horizontal coupling rod, c G;

s, acting horizontally in the centre line of shafts, $n\ h$; and

r' acting along the support $n\ o$.

We have then—

$$S = \frac{R \sin(\gamma - \alpha)}{\sin \alpha} = P,\ s = S,\ r' = R.$$

The forces which worked originally on the engine shaft were P and p; those transmitted upon the tender are S and s, having the same direction and being equal to P and p; also the forces p and p', q and q', r and r', acting in the direction of the lines joining the centres of the axles, balance each other.

It will be evident, therefore, that—

1st, The draw bars transmit entirely upon the tender axle the force acting on the engine axle.

2ndly, They have no tendency to cause the axles to deviate.

3rdly, They do not change the load on the axles.

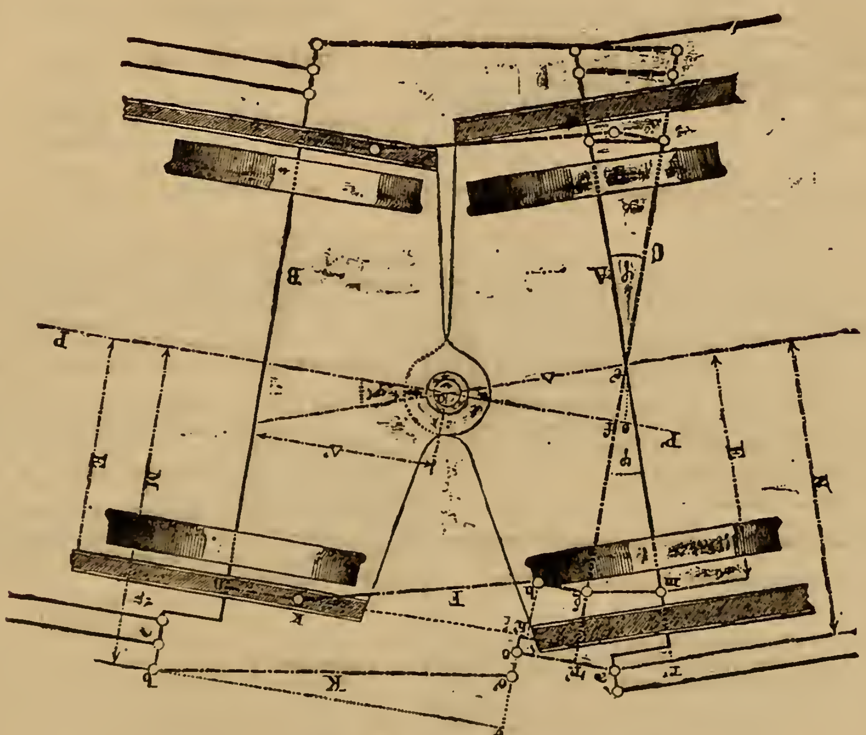
It may here be observed that the friction bolt (Q, Figs. 8 and 9, p. 99, Artizan, May number) would not be required, were it not for the purpose of transmitting a portion of the resistance upon the engine frame.

When traversing very sharp curves, the position of the engine and

tender axles will be such as shown in Figs. 15 and 16 (the first being a plan, the other an elevation of part of engine and tender), and the longitudinal axis of both frames will form an angle ϕ. In Figs. 15 and 16, A is the axle of the tender frame, B that of the engine frame, and C the false axle. For the following calculations we call—

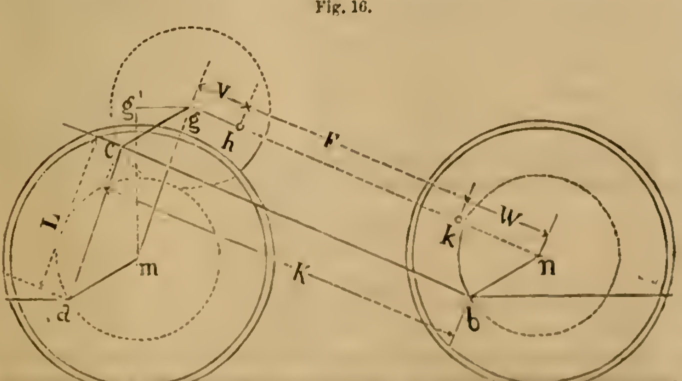
Δ the distance of the pivot o from the tender shaft A.
Δ' the distance of same from the driving shaft B.
D the distance between the wheels of tender frame.
D′ the distance between the extreme of engine frame.
ϕ the angle at which the two frames are placed relatively to each other.
E the distance of pivot from the longitudinal axis of engine frame, or from the centre, m, of the bearing of the false axle.
F the length of the bar $k\ h$ (s, Fig. 1, Plate 233).
K the length of the oblique draw bar $b\ c'$.
L the length of the vertical draw bar $a\ c$.
M the distance of crank pin of the oblique draw bar $b\ c'$ from the longitudinal axis of the engine frame.
N the distance of crank pin of the false axle crank from the longitudinal axis of tender frame.
$2\ l$ the length of stroke = twice radius of crank.
R the radius of railway curve.
v the increase in width of gauge.
w the lateral space allowed between the tyres and rails on the straight line.

FIG. 15.



When the train enters into a curve, the tender axle, A, will describe the angle ϕ along with the longitudinal centre line of the tender, so that the point e will come into the position e'. The false axle, however, will remain parallel to the engine shaft B, on account of the connection through the bar $h\ k$; but at the same time it will describe the angle ϕ round the centre e', sliding, thus, from the engine shaft at a length $= e f$. By this motion, the guide and draw bars connecting the engine shaft with the false axle

FIG. 16.



will also be displaced laterally parallel to the engine shaft, to a length $= e' f$. This displacement involves a diminution of the distance of the false axle from the engine shaft, on account of the obliquity of the guide and draw bars, while the effective length of the latter is reduced at the same time in the direction of the axis of the engine frame; *i.e.*, if the false axle would be displaced laterally parallel to the engine shaft, without coming nearer the engine shaft, the draw bars of the engine frame would be too short. The distance between the engine shaft and false axle has, therefore, to increase or decrease just equal to the increase or decrease of the effective length of the draw bars.

From Fig. 15 will be seen that the lateral displacement of the false axle, parallel to the engine shaft—

$$e' f = \Delta \sin \phi \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The decrease of the length of the draw bar $k\ h$ to $k\ h'$ will approximately represent the shortening of the distance between engine shaft and false axle at the displacement of the latter. As $k\ h$ = F, we have (Fig. 15)—

$$k\ h' = \sqrt{\overline{k\ h}^2 - \overline{h\ h'}^2} \qquad h\ h' = e' f$$

$$\therefore k\ h' = \sqrt{F^2 - (\Delta \sin \phi)^2}.$$

$$\therefore k\ h - h\ h' = F - \sqrt{F^2 - \Delta^2 \sin^2 \phi} \quad . \quad . \quad . \quad . \quad (2)$$

(All these formulæ relate to the actual lengths, not to the dimensions of the parts as shown in the diagrams.)

The shortening of the oblique draw bar may now be obtained from Fig. 16. This shortening will be $= b\ c' - b\ c''$ (Fig. 15):—

$$b\ c'' = \sqrt{\overline{b\ c'}^2 - \overline{c' c''}^2}$$

$$b\ c' = K,\ c' c'' = e' f = \Delta \sin \phi$$

$$\therefore b\ c' - b\ c'' = K - \sqrt{K^2 - \Delta^2 \sin^2 \phi} \quad . \quad . \quad . \quad . \quad (3)$$

The difference, δ, between the equations (2) and (3) will, therefore, denote the difference between the shortening of the distance between the

false axle and engine shaft, on the one hand, and the shortening of the oblique draw bars on the other hand; *i.e.*:—

$$\delta = F - K - \sqrt{F^2 - \Delta^2 \sin^2\phi} + \sqrt{K^2 - \Delta^2 \sin^2\phi} \quad . \ (4)$$

To find the conditions under which the vertical draw bars work, it must be remembered that the false axle is not displaced parallel to the tender axle, but that it describes an angle, ϕ, against the latter. If, therefore, we draw (Fig. 16) a vertical line, $m g'$, intersected by the horizontal line, $g g'$, we shall have a triangle the hypothenuse of which $= L$, while—

$g g' = 2 E \sin \frac{1}{2} \phi$; or, as ϕ is very small,

$g g' = E \sin \phi$, and

$$m g' = \sqrt{L^2 - E^2 \sin^2\phi} \quad . \quad . \quad . \quad . \quad . \ (5)$$

This will be the distance of the centres of the tender and false axles, as measured in the projection, e'; the distance, $m g$ (Fig. 15), will be $= L$.

To find the distance of the crank centres, r and r', from each other, we may perform the same operation of constructing a triangle the hypothenuse of which will be $r r' = L'$. As the vertical side of this triangle will be $= m g'$ (Fig. 16), we have—

$$L' = \sqrt{L^2 + (N^2 - E^2) \sin^2\phi} \quad . \quad . \quad . \quad . \quad . \ (6)$$

and, consequently, the difference between the distances of the points, $r r'$, and the length of the vertical rod will be—

$$L' - L = \sqrt{L^2 + (N^2 - E^2) \sin^2\phi} - L \quad . \quad . \quad . \quad . \ (7)$$

The cranks of the false axles of the tender shaft move in two circles, the plans of which form an angle ϕ; the distances of the crank pins will therefore vary while the cranks revolve. At a certain moment both cranks will form the same angle α with a horizontal plan, and both their horizontal projections will then be $= l \cos \alpha$; the vertical distances of the crank pins from the horizontal diameters will also be equal and parallel; and if, therefore, the centres of the crank pins are joined, and likewise their projections, two more parallel lines of an equal length will be obtained. It suffices, therefore, to determine this length, in order to find the lengths of the vertical draw bars for an angle α.

(*To be continued.*)

ON THE EXPANSIVE ENERGY OF HEATED WATER.

By W. J. MACQUORN RANKINE.*

As the question of the quantity of mechanical energy which a given weight of water, heated to a given temperature, is capable of exerting in the act of partially evaporating without receiving heat, until it falls to a given lower temperature, has been raised in connection with recent researches as to the bursting of steam-boilers, I may point out that the complete solution of that question, for any given liquid, together with a numerical example in the case of water, is given under the head of Proposition XVII., of a paper on Thermodynamics, which was communicated by me to the Royal Society in December, 1853, read in January, 1854, and published in the "Philosophical Transactions" for 1854.

That solution is expressed by the following formula (page 161, equation, 65):—

Energy exerted by each Pound of Fluid,

$$= K \left\{ t_1 - t_2 \left(1 + \text{hyp. log.} \frac{t_1}{t_2} \right) \right\} \ \ldots\ldots\ldots\ldots\ (1)$$

in which K denotes the dynamical value of the specific heat of the liquid, being the product of its specific heat expressed in the ordinary way by "Joule's equivalent;" t_1 and t_2, the initial and final absolute temperatures; the absolute zero being 274° Centig., or 493·2° Fahr. below the melting-point of ice.†

Another equation (Equation 63 of the paper) gives the following value for the excess of the final volume to which the mixed liquid and vapour expand, above the original volume of the liquid:—

$$\frac{K \text{ hyp. log. } \frac{t_1}{t_2}}{\frac{dp_2}{dt_2}} \ \ldots\ldots\ldots\ldots\ldots\ (2)$$

in which $\frac{dp_2}{dt_2}$ denotes the rate at which the pressure, in lbs. on the square foot, varies with temperature, at the final temperature.

* Read to the Institution of Engineers in Scotland.

† In the original paper the absolute zero of heat was assumed to be $272\frac{1}{2}$ Centig. below the melting-point of ice. The value now adopted, 274° C., is deduced from later experimental data.

When applied to the water in a steam boiler, these equations take the following form:—

The value of K for liquid water is 772 foot-pounds per degree of Fahrenheit in a pound of water, or

1389·6 foot-pounds per Centigrade degree in a pound of water, or

423·55 kilogrammètres per Centigrade degree in a kilogramme of water.

The final absolute temperature is 212° Fahr. + 461·2° = 673·2° Fahr.

The corresponding value of $\frac{dp}{dt}$ for Fahrenheit's scale and British measures is 42, and 772 ÷ 42 = 18·38.

Let T denote the initial temperature, as Fahrenheit's ordinary scale; so that $t_2 = T + 461{\cdot}2°$.

Then—

Energy, in Foot-pounds, exerted by each Pound of Water.

$$= 772 \left\{ T - 212° - 673° \ 2 \text{ hyp. log.} \left(\frac{T + 461{\cdot}2°}{673{\cdot}2°} \right) \right\} \ \ldots\ (3)$$

Trial Volume of Expansion of mixed Water and Steam, in Cubic Feet per Pound,

$$= 18{\cdot}38 \text{ hyp. log.} \left(\frac{T + 461{\cdot}2}{673{\cdot}2°} \right) \ \ldots\ldots\ldots\ldots\ldots\ldots\ (4)$$

It is worthy of remark, that *the energy developed depends solely on the specific heat of the substance in the liquid state, and the initial and final temperatures*, and not on any other physical property of the substance.

The following table gives some results of the formula:—

The first column contains the temperature in the ordinary scale of Fahrenheit, with intervals of 36° Fahr. = 20° Cent.

The second column contains the expansive energy of one pound of water, in foot-pounds.

The third column contains the velocity, in feet, per second, which that energy would impress on a projectile of the weight of the water itself; that is, one pound.

The fourth column, the final volume of expansion of the water and steam, in cubic fect per pound.

For convenience, a fifth column is added, containing the initial, absolute, or total pressures in pounds on the square inch.

The last line of the table has reference to the case in which the water would be totally evaporated:—

TABLE 1.

Initial Temperature.	Energy.	Velocity.	Final Expansion.	Initial Absolute Pressure.
Fahr.	ft.-lbs.	ft. per sec.	cubic ft.	lb. to sq. in.
212°	0	0	0	14·70
248	726	214	0·95	28·83
284	2,779	423	1·87	52·52
320	6,052	624	2·73	89·86
356	10,422	819	3·56	145·8
392	15,826	1,010	4·36	225·9
428	22,156	1,194	5·11	336·3
about 2360	about 912,500	about 7,666	26·36	unknown

In the absence of logarithmic tables, the following approximate formulæ may be used for temperatures not exceeding 428°:—

$$\text{Energy, nearly} = \frac{772\,(T - 212°)^2}{T + 1134{\cdot}4°} \ \ldots\ldots\ldots\ldots\ (5)$$

$$\text{Expansion, nearly} = \frac{36{\cdot}76\,(T - 212°)}{T + 1134{\cdot}4°} \ \ldots\ldots\ldots\ldots\ (6)$$

In explanation of the formulæ and tables, it may be added that the mechanical energy in column two is the equivalent of the heat which disappears during the process, being the difference between the whole heat expended and the latent heat of that portion of the water which, at the end of the process, is in the condition of steam at atmospheric pressure.

For the information of those who consider that the liquid portion of the water, owing to its small compressibility, acts like a volley of hard

projectiles, a table is added, showing, for each of the initial temperatures in the previous table, what fraction of a pound of water continues in the liquid state, and how mnch of the energy developed is possessed by that liquid water:—

TABLE 2.

Initial Temperature.	Proportion of the Water which remains Liquid.	Energy Preserved by that Liquid Water.
Fahrenheit.	lb.	ft.-lb.
212°	1·000	0
248	0·964	700
284	0·931	2,587
320	0·897	5,429
356	0·865	9,015
392	0·835	13,215
428	0·806	17,858
....	....	....
about 2,360	0	0

In the formulæ and tables, it has not been considered necessary to take into account the small increase which the specific heat of water undergoes as the temperature rises.

SPIRIT-LEVEL TELESCOPE.

The following is a brief description, by Admiral Sir E. Belcher, of a spirit-level telescope, adapted to a sextant for the purpose of obtaining the altitude of the sun at sea during fog, or for obtaining the elevation of an object of small elevation, which, although obtainable to minutes by a theodolite, could not be obtained by reflection in an artificial horizon.

This invention suggested itself to Admiral Sir E. Belcher when beset by fog on the limits of the Arctic Sea for several days, in the year 1826. His first effort was to attach a spirit-level beyond the horizon glass, and, by keeping a very steady hand, cause the sun to touch the bubble at the moment it became central.

This succeeded well, but was not sufficiently portable or convenient for his purpose; and, on his appointment to the Arctic command in 1852, he had the telescope referred to attached to a Broughton sextant.

The spirit-level occupies a position immediately over the diagonal diaphragm, as in the arrangement of an astronomical telescope. Above the aperture is attached a white reflector, which assists in throwing the bubble on to the level wire in the field; when, therefore, any object is brought down to touch this level guage when it bisects the reflected bubble of the spirit-level, we have the altitude measured by the arc of the instrument.

To those unaccustomed to measurements by reflecting the object whose altitude is demanded in an artificial or mercurial horizon, it is necessary to observe that no accurate measurement can be obtained by such means where the object, as a mountain, does not exceed 10° of altitude; and in inland situations, where it may only be permitted to carry a sextant, this adaptation of the telescope prevents the necessity of carrying the artificial horizon—an instrument, however, of the greatest importance, and, for every purpose of astronomical pursuit in the last degree of precision, absolutely necessary.

ON THE PAPER MANUFACTURES OF NORTHUMBERLAND AND DURHAM.

BY MR. W. H. RICHARDSON.

In consequence of the general disinclination on the part of paper manufacturers to furnish any information or statistics of their operations, this account will necessarily be imperfect. The estimates given have, however, been carefully considered, and are as accurate as possible under the circumstances:—Number of firms in the trade, 12; number of machines making white paper, 10; brown do., 9; quantity of white paper made per year, 3500 tons; brown do., 4500 tons; total, 8000 tons; being about one-twelfth of the entire production of the United Kingdom. Total estimated annual value, £300,000. Coarse materials, as old ropes, &c., used for brown paper, 5200 tons; do. rags, 4000 tons; Esparto grass, 2000 tons; bleaching powder, 400 tons; soda ash, 200 tons; and the quantity of coals used per annum is 35,000 tons. Imports of Esparto grass to the port of Newcastle-on-Tyne for the last three years—in 1860, 1224 tons; in 1861, 2613 tons; and in 1862, 9534 tons. The principal improvements that have been made in the manufacture of paper in late years are in the details and general efficiency of the machinery, whereby a much larger quantity of paper is made with the same apparatus than formerly; and in the superior management of the chemical processes, whereby material that formerly was entirely useless is now worked up into common shop papers; and inferior rags are cleansed and bleached into a good white paper, which formerly were made into coarse paper. The only notable exception to this is the introduction of Esparto grass, the importation of which has been steadily increasing, and, as will be seen from the statistics already given, amounted to nearly 10,000 tons in the year 1862 into the port of Newcastle alone, the greater part of which was, however, forwarded by railway into Scotland, Lancashire, and elsewhere. Newcastle affords special and peculiar facilities for the importation of this material from the east coast of Spain, where it is principally gathered. Vessels load at Newcastle with coke or coals for Spain, and bring return cargoes of manganese, pyrites, copper ore, lead and lead ore, iron ore, and other minerals for the use of the chemical and other manufactories on the Tyne, and, from the lightness of the Esparto grass, one ton of which occupies the space of three to four and a-half tons measurement, they are enabled to carry a full cargo of it in addition to the minerals which serve as ballast, thus materially economising the cost of freight, so much so that paper manufacturers near Edinburgh and in Lancashire find it cheaper to import *via* Newcastle than by way of Leith or Liverpool.

Esparto, or Alfa, as it is called on the African coast, is a coarse grass which grows in sandy places in almost all the countries bordering on the Mediterranean. This grass consists mainly of ligeum, spartium, stipa, tenacissima, and other species of the last-named genus, all very similar in character and general appearance. It has been used from time immemorial for making mats, ropes, &c., and is mentioned in Pliny's "Natural History" as applied to these purposes. Various attempts have been made to manufacture esparto into paper during the last thirty years; one patent for the purpose being dated as far back as 1839, and in France similar efforts have been made for many years. None of these, however, have been practically successful on the large scale, with the exception of the process arranged by Mr. Thomas Routledge, of Eynsham Mills, in Oxfordshire, who has been making printing paper from esparto for the last nine years, and has taken out three patents for the processes employed. He has lately taken a mill at Ford, near Sunderland, for making printing paper from esparto only. Other manufacturers have, however, used it mainly as a blend with rag material. No material alteration in the machinery or apparatus is required for working esparto, and very much less power is required. The successful working of this fibre depends mainly on the careful and proper adjustment of the quantity and strength of the chemicals employed. The quantity of soda ash required for neutralising the gummo-resinous matters in the fibre so as to admit of its being made into a pulp, is very large, though not so great as is required for straw; and the fibre, unlike rags, never having before been subjected to bleaching or other chemical treatment, also requires very much more bleach powder to bring it to a colour suitable for printing paper. The quantities required are from five to six times as much as for cleansing and bleaching the coarsest rags.

The importations of esparto into the United Kingdom for the past twelve months being about 18,000 tons, the use of this article may be estimated to have caused an increased consumption of soda ash and bleach powder of at least 4000 tons per annum; and these chemicals being dear on the continent of Europe is one obstacle to the use of esparto there.

Nearly all newspapers, not excepting that on which the *Times* is printed, contains a portion of esparto, and some of the penny daily papers published in Edinburgh contain only one-fourth rag material. The large supply of paper-making material from this source has been most opportune. Rags are becoming gradually scarcer; coloured rags suitable for making common printing paper were worth 4*s.* to 6*s.* per cwt in 1848, and now worth 9*s.* to 12*s.* per cwt., and this notwithstanding the relief produced by the importation of esparto. This scarcity, the existence of which the jurors' report of the Exhibition of 1862 most unaccountably denies, has been aggravated by the almost total cessation of the supply of waste and tares from the cotton mills; and even with the assistance of esparto grass and cheaper chemicals and fuels, the paper makers in this country have been placed in a most disadvantageous position in respect of the supply of material, in comparison, with their continental rivals, by recent legislation, which, in the opinion of many, will have a tendency to cripple the progress of the trade in this country; the discussion of this subject is, however, not suited for the present occasion.

The greater part of the paper manufactured in this district is of the coarser descriptions, and Newcastle Brown and Tyne Casing which, from a geographical error, is known in Manchester as Scotch Paper, has a reputation throughout the kingdom for toughness and general excellence.

The printing and writing papers of Messrs. Annandale and Son have a deservedly high reputation in the London market. The other description of white paper made in the district are mainly for the daily newspapers, whose consumption of common printing paper has of late years become so enormous as materially to alleviate the depression consequent on the general dulness of trade, arising from the cotton famine; and it is hoped that, notwithstanding the unfairness with which the trade has been treated by the legislature, that, with the resumption of business in Lancashire, it may recover its former prosperity.

THE ROYAL SOCIETY.

ON MAUVE OR ANILINE PURPLE.

By. W. H. Perkin, Esq., F.C.S.

The discovery of this colouring matter in 1856, and its introduction as a commercial article, have originated that remarkable series of compounds known as coal-tar colours, which have now become so numerous, and, in consequence of their adaptability to the arts and manufactures, are of such great and increasing importance. The chemistry of mauve may appear to have been rather neglected, its composition not having been established, although it has formed the subject of several papers by continental chemists. Its chemical nature also has not been generally understood; and it is to this fact that many of the discrepancies between the results of the different evperimentalists who have worked on this subject are to be attributed.

On adding a solution of hydrate of potassium to a boiling solution of commercial crystallised mauve, it immediately changes in colour from purple to a blue violet, and, on standing, deposits a crystalline body, which, after being washed with alcohol and then with water, presents itself as a nearly black glistening body, not unlike pulverised specular iron ore,

This substance is a base which I propose to call *Mauveine;* it dissolves in alcohol, forming a violet solution, which immediately assumes a purple colour on the addition of acids. It is insoluble, or nearly so, in ether and benzine. It is also a very stable body, and decomposes ammoniacal salts readily. When heated strongly it decomposes, yielding a basic oil. Its analysis has led to the formula

$$C_{27}{}^{*} H_{24} N_4.$$

Hydrochlorate of Mauveine.—This salt is prepared by the direct combination of mauveine with hydrochloric acid. From its boiling alcoholic solution it is deposited in small prisms, sometimes arranged in tufts, possessing a brilliant green metallic lustre. It is moderately soluble in alcohol. Carbon, hydrogen, nitrogen, and chlorine determinations have led to the formula—

$$C_{27} H_{24} N_4 HCl.$$

I have endeavoured to obtain a second hydrochlorate, but up to the present have not succeeded.

Platimum Salt.—Mauveine forms a perfectly definite and beautifully crystalline componnd with bichloride of platinum, which, if prepared with warm solutions,separates in the form of crystals of considerable dimensions. It possesses the green metallic lustre of the hydrochlorate, but on being dried assumes a more golden colour. It is very sparingly soluble in alcohol. The analysis of this salt has led to the following formula—

$$C_{27} H_{24} N_4, H\,PtCl_3.$$

Gold Salt.—This substance separates as a crystalline precipitate, which, when moist, presents a much less brilliant aspect than the platinum derivative; it is also more soluble in alcohol than that salt, and when recrystallised appears to lose a small quantity of gold. Its analysis has given numbers agreeing with the formula—

$$C_{27} H_{24} N_4, H\,Au\,Cl_4.$$

Hydrobromate of Mauveine.—This salt is prepared in a similar manner to the hydrochlorate, which it very much resembles, except that it is less soluble. Carbon, hydrogen, and bromine determinations give results agreeing with the formula—

$$C_{27} H_{24} N_4, H\,Br.$$

Hydriodate of Mauveine.—In preparing this salt from the base, it is necessary to use hydriodic acid which is colourless, otherwise the free iodine will slowly act upon the new produet. It crystallises in prisms, having a green metallic lustre. It is more insoluble than the hydrobromate. Its analysis has led to the formula—

$$C_{27} H_{24} N_4; HI.$$

Acetate of Mavveine.—This salt is best obtained by dissolving the base in boiling alcohol and acetic acid. It is a beautiful salt, crystallising in prisms possessing the green metallic lustre common to most of the salts of mauvine. Combinations of this substance gave numbers agreeing with the formula—

$$C_{24} H_{24} N_4, C_2 H_4 O_2.$$

Carbonate of Mauveine.—The tendency of mauveine to combine with carbonic acid is rather remarkable. If a quantity of its alcoholic solution be thrown up into a tube containing carbonic acid over mercury, the carbonic acid will be quickly absorbed. To prepare the carbonate, it is necessary to pass carbonic acid gas through boiling alcohol containing a quantity of mauveine in suspension; it is then filtered quickly, and carbonic acid passed through the filtrate until cold; on standing, the carbonate will be deposited as prisms having a green metallic lustre. This salt, on being dried, gradually loses carbonic acid. From experiments that have been made with the salt, it would appear to have the composition of an acid carbonate, viz.—

$$C_{27} H_{24} N_4, H_2 CO_3.$$

In the analysis of salts of mauveine great care has to be taken in drying them thoroughly, as most of them are highly hygroscopic.

I am now engaged with the study of the replaceable hydrogen in mauveine, which I hope will throw some light upon its constitution. From its formula, I believe it to be a tetramine, although up to the present I have not obtained any definite salts with more than one equivalent of acid. Mauveine, when heated with aniline, produces a blue colouring matter, which is now under investigation. A salt of mauveine, when heated alone, also produces a violet or blue compound.

* C = 12.

THE CHEMICAL SOCIETY.

ON THE QUANTITATIVE DETERMINATION OF PHOSPHORIC ACID BY SALTS OF MAGNESIA.

By Robert Warington, jun., Assistant in the Laboratory of the Royal Agricultural College, Cirencester.

Phosphoric acid is continually found in nature associated with oxide of iron, and also with alumina. It is in this state of combination that we meet with it in soils, coprolites, and other phosphatic minerals, and also in most animal and vegetable products. The accurate determination of phosphoric acid in the presence of iron and alumina is, therefore, a problem of frequent occurrence; and, from its bearings on agricultural economy, of considerable importance.

A method of analysis frequently followed in such cases is first to separate the silica by the ordinary process, next to precipitate the lime by oxalate of ammonia from a solution feebly acid with oxalic or acetic acid, then to concentrate the filtrate, treat with tartaric acid, and finally to add a salt of magnesia and an excess of ammonia. If the tartaric acid has been used in sufficient quantity, the oxide of iron and alumina are held perfectly in solution, while the whole of the phosphoric acid is precipitated as ammonio-phosphate of magnesia.

This process would seem at first sight to include all that could be required. It really, however, involves a considerable source of error, inasmuch as it is found that, under certain circumstances, as mentioned to me by Dr. Voelcker, a tartrate of magnesia is precipitated together with the ammonio-phosphate. According to H. Rose,* indeed, magnesia-salts, mixed with tartaric acid, are not precipitated by ammonia. Experiment shows, however, that this is true only when the materials are employed in certain proportions, and not universally. Thus if we take a mixed solution of chloride of magnesium and chloride of ammonium, render it strongly ammoniacal (the ammoniacal salt being present in just sufficient quantity to prevent the precipitation of the magnesia), and then add a small portion of tartaric acid, we obtain in a short time a considerable precipitate of tartrate of magnesia. If, however, instead of adding a little tartaric acid, a large quantity is employed, the solution, though made as ammoniacal as the first, remains perfectly clear. This reaction appears at first sight somewhat anomalous. The explanation seems to lie in the fact that the tartrate of magnesia thus formed is completely soluble in salts of ammonia, and among others in tartrate of ammonia. That this is really the case may be shown by adding a larger amount of chloride of ammonium to the magnesian solution, which will be found to prevent any precipitate being formed, quite as well as a larger quantity of tartaric acid.

The precipitate of tartrate of magnesia closely resembles the ammonio-phosphate in appearance. It forms slowly, is white and crystalline, remains long in suspension, and deposits a hard crystalline crust on the sides of the vessel. It is sparingly soluble in weak ammonia, and dissolves readily in a boiling solution of chloride of ammonium. I have not yet had an opportunity of determining with precision the exact constitution of this tartrate. Approximate determinations of the magnesia contained in it seem to indicate that it consists of three or four equivalents of base to one of acid. The further analysis of the substance may, therefore, possess some interest.

The amount of error likely to arise in the determinations of phosphoric acid, from the formation of this tartrate of magnesia, will depend, of course, upon the proportion of ammoniacal salts necessary to ensure its perfect solution. The results of various experiments on this point showed that, while this proportion varied considerably according to the state of dilution and the amount of free ammonia present, yet that the conditions under which a precipitate would be formed were, on the whole, by no means unlikely to occur in the ordinary method of determining phosphoric acid. These conditions being (1) the use of a considerable excess of magnesia-salt, (2) a dilute state of the solution, or (3) the presence of much free ammonia; all of which might very likely be found in actual practice.

Under these circumstances it occurred to me that as citric acid was equally capable, with tartaric acid, of preventing the precipitation of oxide of iron and alumina, it might be well to try its behaviour with magnesia. Some experiments were, therefore, undertaken to this end, and with complete success. Various proportions of the solutions of chloride of magnesium, citric acid, and ammonia, were mixed together, but in no case was there the slightest indication of any precipitate being formed. Here then is an easy solution of the difficulty. We have but to substitute nitric acid for the tartaric acid usually recommended, and the source of error is at once removed, and there is no longer any ground for fear lest the precipitate of ammonio-phosphate of magnesia should be contaminated with another salt. Citric acid will be found more especially useful in small operations, as the conditions favourable to the precipitation of the tartrate of magnesia are then most frequently present.

It is scarcely necessary to add that when either citric or tartaric acid is used to prevent the precipitation of oxide of iron, such a quantity must be employed that the solution when made ammoniacal shall be of a somewhat greenish "lemon tint." If less acid has been added, and the solution is yellow, orange, or of a reddish colour, the magnesia precipitate will be perceptibly contaminated with oxide of iron.

* Gmelin, Cavend. Soc. Ed., vol. x. p. 290.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.

The October meeting of this society took place on the night of the 3rd ult., Mr. Joseph Newton, of the Royal Mint, occupied the chair; and the proceedings were commenced, as usual, by the reading and confirmation of the minutes of the preceding meeting. Afterwards the chairman read a communication from M. Achard, C.E., in reference to sundry queries which had been put, but not answered, when, a month before, Mr. Gettliffe communicated his paper on "Boiler Explosions and Railway Accidents." It will be remembered that M. Achard's apparatus, then described, was intended for the maintenance of a constantly level feed in steam boilers; and the first of the queries ran as follows:—"If the float, refusing to act, causes the index to remain at zero, while the water falls in the boiler, how can the alarum bell, in consequence of the non-interruption of the electro current, be made to give the required signal?" The answer to this objection was, that in M. Achard's arrangement a stone float was immersed in the water with a counterpoise on an exterior shaft. The articulation consisted in the friction of a steel roller on a plane of polished cast-iron, instead of the old stuffing-box system, which was in many respects imperfect and liable to derangement. The resistance of the rolling friction was insignificant as compared with the gravitation of the stone float, and with that of the exterior counterpoise weight. The float known as "Bourdon's" also neutralised the objection raised; for it was scarcely possible for it to refuse to work freely, and it indicated alterations in the water level to the minute difference of 1·24th of an inch.

In reply to the second question raised—"Would it not be possible to cause the conducting wire to pass through the boiler, and communicate directly with the float?" M. Achard stated that the plan would be quite practicable. He had carried it out with success at Lyons, in the manufactory of Messrs. Coignet. In that case, the conducting wire was subjected to continual friction, which prevented oxidation, and the current circulated quite as freely as with Bourdon's float. The disadvantage of the arrangement, however, was that it precluded the application of an indicator on the face of the boiler, which legally was imperative in France. The Bourdon float, therefore, superseded it, and it met every requirement.

The third of the series of queries was—"Which would be the best and most economical means of keeping the automatic regulator in operation during the temporary stoppage of the machinery and the absence of the workmen?" It was replied that, in order to secure this desideratum, which had not escaped the early consideration of the inventor of the regulator, he had at first added to it a direct electrical bell, which rang the alarm by means of the circulation of the electrical current, so that when the current no longer circulated for the regulator, it circulated for the direct electrical alarum—this latter operating notwithstanding the suspended action of the machinery. Of course the alarum in such case might be fixed in any convenient place—the office of the manager of the factory, for example. It had been found that this was but an extra precaution, which it was not absolutely essential to take, for the water in the boiler never descended, during such temporary suspension, more than an eighth or a quarter of an inch. A little reflection, indeed, would show that, when an engine was stopped *pro tem.*, the index of the regulator pointing to zero could not, owing to the non-consumption of steam, decrease more in height than had been stated.

Mr. T. Miller then read a very elaborate paper on an "Entirely new Method of Coating Telegraph Wires." This was illustrated by a series of admirably-finished diagrams, and was replete with interest. At a future period we may give an extended report of this communication, but lack of space at present compels us to summarise its principal features. Mr. Miller proposes to cut sheets of india rubber from blocks in such a manner that the knife-cuts or corrugations shall run in a longitudinal direction, or nearly so, with the sheet. He has also constructed an apparatus for preparing the strips for the covering machines, as well as covering machines themselves. In the latter, the principal points of improvement consist in the employment of sets of hollow spindles placed one within the other, and to be driven at different speeds. Another arrangement is the drawing or stretching apparatus, mounted on spindles, and to act independently of the friction of the bobbin on its spindle. A third main characteristic of the series of ingenious contrivances in question is the application of a current of electricity, by the action of which the working of the covering machine will be self-actingly stopped, when the insulation is imperfect.

The chairman remarked, at the conclusion of Mr. Miller's paper, that he had rarely heard a more complete description of a variety of ingenious combinations of machinery for the effecting of an important object than that which he had just listened to. In every way Mr. Miller deserved their thanks—in the first place, for the demonstration of his skill as a mechanic and draughtsman; and in the next, for the clear and intelligible manner in which he had put the whole subject before the meeting.

BOOKS RECEIVED.

"A Practical Treatise on the Science of Land and Engineering Surveying, Levelling, Estimating Quantities, &c." With illustrations. By H. S. MERRETT, Architectural and Engineering Surveyor. London: E. and F. N. Spon. 1863.

"Chemical Technology: or, Chemistry in its Applications to the Arts and Manufactures." By THOS. RICHARDSON, M.A., Ph.D., F.R.S.E., M.R.I.A., &c., and H. WATTS, B.A., F.C.S., Ed. "Journal of the Chemical Society." Second edition. Illustrated with numerous wood engravings. Vol. 1. Part 3. No. 2.

"Acids, Alkalies, and Salts: their Manufacture and Applications." London: H. Baillière, 219, Regent-street. 1863.

"Victoria Toto Cœlo: or, Modern Astronomy Recast." By JAMES REDDIE, F.A.S.L. London: Robert Hardwicke, Piccadilly. 1863.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents

To the Editor of THE ARTIZAN.

SIR,—I think such a paper as that of Mr. Grier, on "Momentum and Fluid Resistance," ought not to be allowed to pass without remark in your journal.

I have made some hundreds of experiments similar to those of Mr. Grier, and the results which I have obtained appear in every case to be totally opposite to his peculiar doctrines. Let every one who takes an interest in the subject, and has any doubt, repeat them for himself.

Tubes of different sizes were allowed to drop from different heights, or to slide down nearly perpendicular grooves into small damp sand. The weight of the tubes could be increased at pleasure, by placing weights in the inside. Their ends were conical, rounded, flat, or concave. The height of fall was measured from the surface of the sand to the bottom of the hole. To ensure similar conditions as nearly as possible, the sand was stirred up after each experiment, and a 24oz. weight placed gently on it. From ten to twenty experiments were tried in the same way, and the average taken.

1. It was found that the depth penetrated into sand, weight being the same, was nearly proportional to the velocity, as measured by the square root of the height fallen.

2. It was found that the penetration, other things being equal, was nearly proportional to the square root of the weight; for instance—

	oz.		oz.		oz.		oz.
Weight	1	...	2	...	3	...	4
Penetration	210	...	276½	...	370	...	429
Ratio of square roots of weight	210	...	290	...	360	...	420

Now, it will scarcely be doubted that, all other things being the same, the momentum of a falling body is proportional to its weight. It follows that the penetration is proportional to square root of momentum. But we have seen above, and Mr. Grier himself states, that penetration is proportional to velocity. Therefore, velocity is proportional to square root of momentum, and momentum to square of velocity.

3. It was found that a weight 2 falling a depth 1 penetrated almost exactly the same depth as a weight 1 falling a depth 2; weight 3 depth 1 = weight 1 depth 3; weight 4 depth 1 = weight 1 depth 4, nearly. On the other hand, a weight = 2 with velocity = 1 penetrated a much shorter distance than a weight = 1 with velocity = 2. Thus—

Weights	1oz.	...	2oz.	...	2oz.
Heights	16ft.	...	8ft.	...	4ft.
Penetration in sixteenths of an inch	59	...	61	...	44

Twenty experiments each:—

Weights	1oz.	...	2oz.
Heights	14in.	...	7in.
Sum of penetrations	181	...	182¾

Ten experiments each:—

Weights	1oz.	...	3oz.
Heights	3in.	...	1in.
Penetration	65¾	...	69

It will be observed that the penetration in each case is rather less for the higher elevations. This may be easily accounted for. In the 16ft. experiment the weight of the tube was about 1½oz., area of greatest section, 0·6in. If the resistance of the air be calculated, and the height fallen be measured, as in fact they ought to be in every case, from the very bottom of the cavity made by the penetration of the weight, the force expended being actually proportional to the entire height fallen, it will appear that the number 59 in that experiment should be raised to about 60·4. By the same rule, in the next series, 181 would be raised to 184, and in the last 65¾ should probably be about 67½, actual height in inches uncertain.

These facts, I think, are in accordance with the law which Mr. Grier himself affirms, but which his experiments appear to contradict—that the momentum is proportional to the square of the velocity, when it is measured by the distance which a body is propelled against a uniform resistance. It must be remembered, however, that the resistance of sand to a falling body is not uniform, but increases with the depth penetrated. In Mr. Grier's experiments with the steel spring, it is evident, from his own account, that the forces expended in compressing the springs were 1, 4, and 9. In the first case, distance compressed 1 mean force ½, product ½; second case, distance 2, mean force 1, product 2; third case, distance 3, mean force 1½, product 4½. Then ½, 2, and 4½ are as 1, 4, and 9.

The result of the collision of oscillating non-elastic bodies, though apparently contrary, are, in reality, perfectly consistent with the doctrine that $V^2 = M$.

With regard to fluid resistance, if the foregoing observations be correct, and if action and reaction are equal, it must necessarily be proportional to square of velocity for a given distance, and to cube of ditto for a given time. The simplest experiments, of which I have tried many myself both in air and water, abundantly prove that such is the fact, in my opinion at least. Nothing can be easier than to insert a few feathers, radially, in the edge of a thread bobbin, put a wire through for axis, and hang a weight to the thread; then observe the time of descent by the oscillations of a plummet, when it will be found that a fourfold weight is required to double the velocity, and of course an eightfold force will be expended in a given time.

A few years ago, I saw in THE ARTIZAN a list of the performances of certain ships, which convinced me that the same thing was true with regard to them; or, at all events, much more nearly true than the contrary opinion, and which list

was contributed by a person holding just the same opinions as Mr. Grier. Whether ships could avoid this vast increase of resistance by being forced out of the water, or driven over its surface, is quite another question.

M. C.

Obituary.

WILLIAM BUCKLE, ESQ., C.E., M.E.

Assistant Coiner, Royal Mint.

We have the painful duty, this month, of recording the decease of the above named estimable gentleman. Mr. Buckle was one of a rather numerous class in this country, and who may well be designated, as its "unrecognised great men." It is well known that in the engineering profession, especially, there are many in England who may, with great propriety, be so classed, men, whose names are seldom brought before the public during their own lifetime, but whose careers are not the less fraught with usefulness to the community.

Mr. Buckle's example may well be submitted to those who are at present working at the bench or the lathe, as one worthy of imitation. Mr. Buckle's father was a millwright and engineer, and was born at Alnwick, on the 10th of October, 1752. He devoted much attention to the improvement of agricultural machinery in his earlier years, and at a later period was associated with the celebrated Earl of Dundonald in the realisation of his numerous schemes and inventions. In 1849, and at the mature age of 90 years, the elder Buckle died. The subject of our present remarks was the second of three children and was born at Alnwick on the 29th of July, 1794, very soon afterwards his parents removed to the town of Kingston-upon-Hull, in Yorkshire. At this place he received his education, and the family again migrating, he came to London, in his fourteenth year. Messrs. Woolf and Edwards shortly after received him into their employment as an apprentice, and as their work was of a varied character, embracing millwork as well as engineering, young Buckle was most favourably situated. He gained a general knowledge of both, and in his leisure hours supplemented the defects of his early education by attending evening schools and drawing classes. On the completion of his apprenticeship, his employers recommended him to the Prince of Hardenburg, as a fit and proper person to superintend the introduction of steam-boats upon certain rivers and lakes in Prussia. The recommendation was accepted, and Mr. Buckle departed for Memel. Did space permit, many interesting details might be given of Mr. Buckle's exertions in Prussia, and of the successful way in which his mission to that country was effected. It must suffice, however, to state that he gained the approbation of those who had engaged him, and after four years he returned to England. Providentially, he had been fortunate enough to save from drowning a young lady of the Prince of Harlenburg's family, and for this service he was awarded a gold medal. The steam-boat experiences of Mr. Buckle in Prussia was deemed valuable enough to qualify him for home service of a similar character, and we find him next in the employment of Messrs. Boulton and Watt.

In the early part of 1824, the Government determined to institute a steam packet service between Holyhead and Dublin, and to the eminent firm just named was entrusted the task of fitting engines to the boats intended for the work. The *Ivanhoe* was the first of them, and Mr. Buckle was sent down to Milford Haven for the purpose of putting in her engines. By dint of very extraordinary exertion, and by availing himself of all the hours of each week including Sundays, the young engineer speedily started the engines of the *Ivanhoe*. She was the precursor, therefore, of that magnificent line of packets which now connects this country with the Emerald Isle, and Mr. Buckle had the honour of superintending her first trip across the Channel.

To the same gentlemen was committed the honour of conducting, so far as his speciality was concerned, King George IV. to and from Ireland. This voyage took place on board the *Lightning* steam ship, and her name in memory of the event, and at the request of the king, was soon after exchanged for that of the *Royal Sovereign*. For many years subsequently she was known by that title, but eventually becoming dilapidated, and, by contrast with newer vessels, unsightly, her name was again changed for that of the *Monkey*. At this moment the identical vessel is used under the latter contemptible designation, as a tender to H.M.S. *Fisgard*, at Woolwich, and not unfrequently does duty on the Thames as a tug.

Mr. Buckle is next heard of at the Soho Foundry or factory, whither he had been summoned by Messrs. Boulton and Watt, to take the post of foreman, and that office he continued to fill until the year 1851; and during the whole of the intermediate time was in the enjoyment of the confidence and the friendship of the heads of that gigantic establishment. Of his works, during this period, more will, probably, be said bye-and-bye. They were numerous and varied, and much of the celibrity attained by the Messrs. Boulton and Watt is, undoubtedly, due to the skill and energy of their talented foreman.

In 1851 Mr. Buckle bade adieu to Soho, and came, at the instance of Sir John Herschel, to the Royal Mint, Tower Hill. A total change in the internal management of the Mint was consummated in the year rendered memorable by the first International Exhibition, and Mr. Buckle then became one of its principal officers. Captain (now Colonel) Harness, R.E., was undoubtedly the main-spring of the movement for re-organising the Mint at the time named, and had justice been done to that distinguished officer, he would thenceforth have been created Master of the Money Manufactory. Mr. Buckle, however, rendered efficient aid in the task, and afterwards, with the rank of a senior clerk, he enjoyed the title and emoluments of Assistant Coiner. This post he continued to fill until the day of his death, which unhappy event took place on the 30th ult., at his residence within the walls of the Mint.

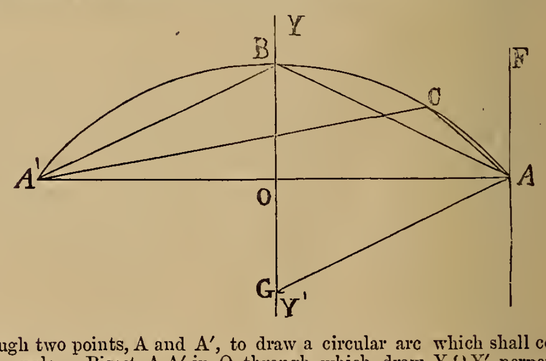
Few men have led a more blameless life than William Buckle, or have been more fortunate in possessing true friends. He was the incarnation of kindness and amiability, and his family, consisting of a widow and a son and daughter, have therefore to lament the loss of a most affectionate husband and father. The deceased gentleman, who had nearly completed his seventieth year when the "icy hand of death" arrested his earthly pilgrimage, was buried at Kensal Green Cemetery on the 6th inst., his grave being surrounded by a crowd of sorrowing relatives, and friends, and workmen who had served under him.

We believe that his colleague in the Coining Department at the Royal Mint, and who should become his successor in the Assistant Coinership there, is preparing a lengthy memoir of Mr. Buckle, and that before many months are past it will be in the hands of the public.

NOTICES TO CORRESPONDENTS.

Workman.—1. The hole in centre of beam may be increased without affecting the strength of the beam, provided the dimensions of the cast-iron centre piece be increased in proportion. 2. No openings, whether circular, square, or diagonal, will affect the solidity of the construction, if you consolidate the beam by the beads alluded to in No. 3. 3. The bead proposed at the top and bottom of the beam will considerably contribute to impart additional strength to the construction; the rivet holes will diminish this effect to a very small extent only. We should, however, suggest to add on each side a central longitudinal rib, of about the same proportions or a little larger than the bead, the latter being all but useless without this rib. We do not know upon which of Templeton's formula you have calculated the strength of your beam; we cannot, therefore, tell you whether your calculation is correct or not.

C. B.—We have been favoured with Dr. Rankine with the following in reply to your query referring to the diagram given in The Artizan of September last, illustrative of Dr. Rankine's paper read at the British Association Newcastle Meeting—"Abstract of an Investigation on Plane Water Lines:—



Through two points, A and A′, to draw a circular arc which shall contain a given angle. Bisect A A′ in O, through which draw Y O Y′ perpendicular to A O A′; through A draw A F parallel to O Y; from A F, at the point A, lay off F A G equal to the given angle; the point G, where A G cuts Y O Y′, will be the centre of the required arc, which may then be drawn. Let A B A′ be the arc, then every angle contained in it, such as A B A′, or A C A′, will be equal to F A G. If the middle point O is given, it is obviously unnecessary to lay down A′ on the paper.

Inquirer.—The particulars shall be given in our next.

A Subscriber (Manchester).—We have not yet succeeded, but should we find information to the point, we will insert the particulars in the next or any of the following numbers of The Artizan.

A Subscriber (Hull).—1. Apply by letter to the Secretary of the Admiralty, Whitehall. 2. We do not know of any work giving the information you seek.

"SILENTIO."—1. *Both* are very good and useful. We should, however, recommend the preference to be given to the former. The price is 7*s.* 6*d.*—2. A cylindrical boiler with two internal flues. 3. Thanks for your suggestion.

C. K. (Sweden).—We have a communication for you awaiting your arrival in England.

E. S.—In reply to the enquiry made by you and other correspondents, as to what is known as the *Swedish Piston*, we are informed by Mr. Nystrom that this arrangement of piston was invented by Capt. Carlsund some twenty years ago.

Fig. 1.

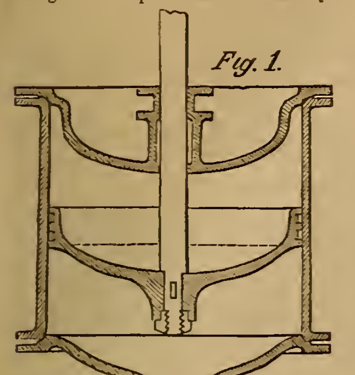


Fig. 4.

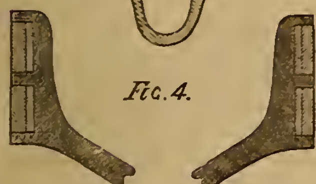


Fig. 2.

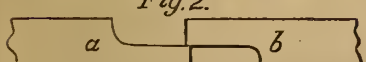


Fig. 3.

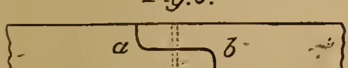


Fig. 1 represents a section of a steam cylinder, with Carlsund's piston; figs. 2 and 3, portions of the packing rings; and fig. 4, a section of the periphery part of the piston. The higher the steam is used, the more concave should be the piston; that in fig. 1 is proportioned to about 30lb. pressure to the square inch. This form makes this piston and cylinder-heads sufficiently strong with very thin metal. The two packing rings surrounding the piston are made of cast-iron, each in one piece, jointed as shown in figs. 2 and 3. The diameter of the ring is cast about the same as that of the cylinder; for large cylinders a little larger, and for small ones smaller. The rings are turned on the four sides, and the joint cut, as shown in fig. 2; the line *a b* should be perfectly parallel with the sides. The joint is then finished as in fig. 3, with the greatest care that the seam *a b* is perfectly tight, and the outside diameter of the ring a little larger than that of the inside of the cylinder, sufficient to allow for turning. A strap is now screwed around the ring, to keep the joint in position; a hole of about one-quarter the thickness of the ring is drilled in the joint, and a pin *c* inserted, and the ring is placed on a centre-plate turned to the correct diameter of the inside of the ring, the strap taken off, the ring turned to the correct diameter of the cylinder, and the sides to the correct size of the grooves in the piston. This work requires a skilful workman, and the greatest care must be taken that the rings be not too small for the grooves; should there be any play, it will jar when the piston is in motion. The breadth of the ring is made about 0·3 the square root of the diameter of the cylinder in inches, and the thickness about one-third of the breadth. Capt. Carlsund used to put canvass in the bottom of the grooves, but with high steam the canvass will burn. Mr. Nystoms prefers to employ vulcanized india rubber in the grooves, as shown by the dotted part fig. 4, which is found to answer very well; when the india rubber becomes hot, it expands, and presses the ring gently and uniformly to the sides of the cylinder, and makes the piston perfectly tight. Pistons and cylinder-heads of this shape will weigh about one-half of the ordinary form.

THE MANUFACTURE OF IRON AND STEEL.

Professor Fleury, in a paper lately read by him at the Franklin Institute, Pennsylvania, U.S., stated that chemical analysis has demonstrated the cinder or slag drawn from puddling and re-heating furnaces (and which is generally thrown away as useless) to contain invariably from 25 to 50 per cent. of metallic iron, combined and mixed with sulphur, silica, lime, and alumina, forming a very peculiar brittle compound, defying the most ingenious devices of ironmasters to separate. Prof. Fleury states he has, after many unsuccessful attempts ,succeeded in extracting good cast, as well as wrought iron, and has even been so fortunate as to produce from this refuse material a good quality of cast steel.

Two great difficulties had to be overcome. 1st. The oxides and metallic iron in these cinders are combined with silica and other substances in such a peculiar way, that, by remelting the same in the puddling, cupola, or other furnace, very little of the metallic iron can be extracted; the combination withstands even the high heat in a steel crucible. 2nd. By reworking the cinder with lime alone, or with lime mixed with charcoal and clay, the product is red-short, and often red and cold-short. The sulphur, silicon, and phosphorus remains still combined with the iron. All the attempts to extract good neutral iron from the puddling cinder by dry admixture of lime were unsuccessful; no other means remained but to destroy or loosen the tenacious chemical combination of these substances before they were placed into the furnace.

Unslacked burnt lime possesses the peculiar property of decomposing silicates during hydration, or slacking, as it is commonly called. This can easily be demonstrated by pouring water slowly into an intimate mixture of sand and freshly burnt lime: the outside of the sand grains will yield to the lime gelatinous silica, and, when dried, form with it a strong chemical combination, silicate of lime—the base of a good mortar. Taking advantage of this fact, a proper per centage of powdered burnt lime was mixed with the fine ground cinder, and after wetting the whole with water, the mixture was exposed to the drying influence of the atmosphere. The dry compound was then heated in a common puddling furnace, and treated like pig-iron. 50 per cent. of wrought iron was obtained, which however retained still some traces of sulphur, leaving the iron somewhat red-short. To extract these last traces of sulphur, a small per centage of a chlorine salt was dissolved in the water used for slacking the lime, and the desired result was attained. The process is also applicable to the working of siliceous ores, and can be performed in the puddling, cupola, or blast furnace. The preparation of the cinder, cost of lime, salt, &c., does not, we understand, exceed 9*s.* per ton, and, if properly worked, the result is invariably a good quality of iron.

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

SOLICITORS TO PUBLIC COMPANIES.—*In re* the Phœnix Life Assurance Company, before Vice-Chancellor Wood, an important question was raised as to the right of the solicitors of the company (which is in course of winding-up), to be allowed certain costs claimed by them in respect of actions brought and defended on behalf of the company, in reference to marine insurance business, which had been already held to have been *ultra vires*; and the Vice-Chancellor decided that where a company engaged in a business not authorised by its deed of settlement, and the solicitors to the company, knowing that the business was unauthorised, were employed by the directors to bring an action, and to defend other actions in respect of claims arising out of the unauthorised business, the solicitors must be considered with respect to such actions as the solicitors of the directors, and not of the company, and that they could not prove for their bills of costs upon the company's assets. His Honour said, that without laying down any rule, that every solicitor was to be considered aware of all the consequences of acting in matters which might or might not be within the scope of a company's powers, he might say that solicitors appointed by the directors of a company were retained on behalf of the company, and were not the mere servants of the directors. On the contrary, it was their duty to advise the company to adhere to the regulations of the deed of settlement, and not to carry out the whims of the directors.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

COST OF THE CENSUS.—The expense incurred at the central office (exclusive of postage) and in payment of the local officers in taking the census of England and Wales, was £86,728 in 1841, £93,132 in 1851, and £95,719 in 1861. This was in 1841 £5 8*s.* per thousand of the population, in 1851 £5 4*s.*, and in 1861 £4 15*s.* 5*d.*, or rather more than a penny per head for every man, woman, and child in the kingdom. 34,966 local officers were employed in taking the census of 1861.

IMPORTANT SANITARY MEASURE FOR LIVERPOOL.—The Liverpool town council, on the recommendation of the health committee, have at length resolved to apply to Parliament for powers to purchase the courts and alleys of the borough, in order that they may effect comprehensive improvements, and prevent, if possible, the continuance fever and other diseases in these localities. One-fifth of the population of Liverpool at present reside in

these courts and alleys, which are 3103 in number, containing 18,610 persons, and many of which places, are so ill-ventilated that fever is never absent. It is proposed to charge the cost of purchasing this property on the general rate authorised to be levied by the local sanitary Acts, the rate not to be increased beyond 1*d.* in the pound in any one year.

Artificial Light.—The foundation-stone of the new retort-house of the Manchester Corporation Gasworks, at Gaythorn, has been laid by the Mayor (Mr. Abel Heywood), and at the luncheon, which was afterwards held at the Town Hall, Mr. Curtis, the chairman of the gas committee, stated that by Mr. Macfarlane's arrangement, as it would be carried out in the new works, they would be prepared to carbonise in each stack 4 tons 16 cwt. of Cannel, producing 48,000 cubic feet of gas, in 24 hours, with an expenditure of 15¼ cwts. of coke. Thus in the same space of building they would double the amount of their production, without increasing the cost of their expenditure for fuel. Whether they had arrived so far as they could go in these respects time alone will show, but he thought they had already accomplished a great deal. He found, by looking at the books that the consumption of gas on one day recently had been 3,233,000 cubic feet. He had calculated how many sperm candles would be needed to give the amount of light supplied by that quantity of gas, and he found it would be 3,960,000. Mr. Rumney, in responding to the toast, "The Chairman of the Sub-Committees, and Success of the Building," said that one of the chief questions in connection with the extension of their gas-producing power was whether it was likely that there would ever be a cheaper artificial light? He thought there was no probability of such a thing at present. Experiments were made last winter by Dr. Frankland, an eminent chemist, now resident in London, and formerly of Owen's College, the result of which deserved to be widely known. He found that the illuminating power of 20 sperm candles for ten hours would cost as follows in the several artificial lights named:—Spermaceti candles, 6*s.* 8*d.*; paraffin candles, 3*s.* 10*d.*; tallow candles, 2*s.* 8*d.*; sperm oil, 1*s.* 10*d.*; paraffin oil, 6*d.*; coal gas, 4½*d.*; Cannel gas, 3*d.* Another consideration was that some persons complained of gas causing heat and impurity in the air, and it became a question as to whether it created more heat and impurity than other artificial lights. The same gentleman conducted experiments to find that out, with these results:—Taking the illuminating power of 20 sperm candles as the standard, it was found that in a room of a certain size, and in a given time, tallow candles produced 10 cubic feet of carbonic acid gas, and an amount of heat represented by 100; spermaceti candles produced 8·3 cubic feet of carbonic acid gas, and heat, 82; paraffin candles, 6·7 cubic feet of carbonic acid gas, and heat 66; coal gas, 5 cubic feet of carbonic acid gas, and heat 47; and Cannel gas, 4 cubic feet of carbonic acid gas, and heat 32. This disposed of the idea that gas caused more heat, and made the atmosphere more impure, than other artificial lights.

Inspection of Steam-Engines employed in Agriculture.—A general meeting of the Suffolk Agricultural Association has been held at Ipswich, to consider the propriety of adopting some precautionary measure for preventing accidents from steam power employed in agriculture, the necessity of some provision of this kind having been most forcibly shown by the recent calamitous accident at Charsfield. The meeting was presided over by the Earl of Stradbroke. After some remarks from the chairman, Mr. C. Welton proposed the following resolution:—"To meet the present emergency, it is proposed that for this county the Agricultural Association appoint a competent engineer as inspector of steam-engines employed in agriculture, such inspection to be made at least half-yearly, at a certain fixed payment per engine for each inspection, which, with the exception of a small annual sum from the funds of the association, is to be at the expense of, and paid by, the owners of the engines respectively. The inspector will be required to keep a registry of all engines inspected by him from time to time, with the name of the makers, the date or age of the engine, and limited amount of pressure in pounds to the square inch upon the boiler, together with the date of the last inspection, all of which to be painted in large and legible letters (of not less than half an inch) upon the outside of the boiler. He shall also examine the engine-driver as to his fitness, and if satisfied give him a certificate, which will enable him to wear a badge on his right arm above the elbow, having a number upon it corresponding with the inspector's book; this badge or distinction he will be obliged to wear when at work with the engine. The inspector shall, once in every year, make out a schedule of engines examined by him, with a report upon their condition, together with any suggestions which may occur to him in the course of his inspection, and forward a copy of the same to the secretary at least one week before the annual general meeting of the association; which report shall be read before the general body of the members, and printed in the books of the rules and regulations of the society." This was seconded, and after a long discussion was finally adopted, but left, however, for reconsideration. A committee was then appointed to obtain such information as might seem necessary for carrying the resolution into effect; and it was understood that it would report in the course of a month.

Large Hammer Casting.—At the Ouseburn Engine Works there has been cast a large frame for a steam-hammer, on Mr. Robert Morrison's patent. The pit for the same was 45ft. long, 24ft. wide, and 12ft. deep, and required about 55 tons of metal, 28 tons of which were held in a large air furnace erected for the purpose, and the remainder in two ladles. The running of the metal occupied five minutes and nine seconds. The whole of the operations were under the management of Mr. James Turnbull, and were successfully carried out.

Steam Boiler Gas Furnaces.—The patentee of this proposed substitute for coal is Mr. A. Jackson, of the East-India Chambers. A boiler to which the gas fuel is applied in Messrs. Cutler's works, in Wenlock-road, City-road, is about 3½ft. in diameter, and it is perforated by a great number of perpendicular tubes, through which the heat of the gas flame passes so as to present a large heating surface. The quantity of gas consumed per hour is stated not to exceed 200 cubic feet, which will guarantee 2lb. weight of steam per minute. The engine supplied with steam from the boiler is equal to four-horse power. The steam indicator showed that the pressure was not steadily maintained above 30lb. to the inch. As there is no smoke from such a furnace no chimney is required, the vaporous products of combustion being carried off by a small tube. It is stated by Mr. Jackson that in his application of gas its cost is considerably greater than that of coal for generating an equal quantity of steam, but he asserts that the extra cost of fuel is more than compensated by the saving of labour.

The Paris Universal Exhibition.—The permanent exhibition now building at Auteuil, with the whole of its annexes, will cover a space of about 29 acres; out of these, the "palace" proper is to occupy 10, the annexe devoted to machinery, agricultural implements, and the flower-show, 3½ acres. Squares and gardens will be placed in those parts not occupied by the building. The palace proper will form a large parallelogram of about 440 yards in length, by 150 yards wide. Four pavilions will project at the transverse axis of the building; the doors will be placed between them, and in the centre of the fronts, viz., the main entrance on the Boulevard Neuf, and the egress on the road facing the Parc-aux-Princes. Between the pavilions and the doors will be 100 "arcade windows," the height of which will be equal to that of the highest houses of Paris, so as to enable them to throw light both on the ground and first floor of the building. The palace is divided inside longitudinally into three parts, which form in the centre a grand nave of a width of 44 yards. The side galleries have a width of 35 yards each. An iron and glass tower will be placed in the centre at a height of 110 yards from the ground to top of tower. The building is to consist of wrought and cast-iron, the total weight of which is 10,500 tons; stone will be partly used for the exterior only of the building. The main doors will be adorned with sculptures and statues, denoting the object of the undertaking. The ground floor will communicate with the first floor through eight staircases of 26ft. width each.

The Vienna International Exhibition.—We understand that the plans for the Vienna Exhibition of 1866, drawn by the Architect Herr Lohr, are now ready. The building will be erected in the Prater, on the right side of the main avenue, near the Sophienbrucke. It is to consist of a main building of 466 yards in length, by 52 yards in width, and two uncovered annexes behind, in which the agricultural show is to take place. The whole of the building will consist of stone and timber. The reservoirs and waterworks inside the building will be supplied from the Danube Canal, by means of a steam engine, and a tramway will connect the exhibition with the Vienna Metropolitan Railway, so as to allow the goods to be conveyed from the stations direct to the building. The total cost is estimated at 3,000,000 florins (£300,000). The Austrian Government is to guarantee the interest and make up the deficit.

The Irish Exhibition of 1864.—The organisation of this enterprise is making satisfactory progress. In various parts of the country meetings have been held in furtherance of the movement, and in every instance the proposal has been favourably received. Messrs. Bagot and Walker represent the Royal Dublin Society, under whose auspices the exhibition will be held.

Water-pipes.—Wrought-iron water-pipes, lined and coated with hydraulic cement mortar, are in use in San Francisco. These pipes have spigot-joints, can be back-filled as soon as laid, and capped in the same manner as cast-iron pipes.

NAVAL ENGINEERING.

The "Salamander," paddle wheel sloop, 6 guns, 818 tons, 220 horse-power, having undergone repairs and been fitted with new boilers in Sheerness Dockyard, underwent the final trial of her engines (previous to her being commissioned) off the measured mile at Maplin Sands, on the 8th ult. She attained a true mean speed of 6·721 knots, with 18·16 revolutions of engines; pressure of steam, 13; load on safety valve, 13; vacuum starboard, 26; and port, 25½. Her draught of water was, forward, 15ft. 11in., and aft, 15ft. 10in.; diameter of wheels, 20ft.; immersion of floats, 2ft. 2in. The circle was turned at full boiler power in 5 min. 30 sec.; helm starboard, 33 degrees; diameter of circle, 460ft.; the half circle was turned with helm starboard, 30 degrees, in 2 min. 20 sec.; with helm port, 30 degrees, in 2 min. 22 sec. The trial equalled all that had been expected.

The Screw Steam Corvette "Pelorus," 22, Capt. Boys, made a trial trip outside Plymouth Breakwater on the 6th ult. Her mean speed in six runs at the measured mile was 10·913 knots, mean revolutions, 55·7. Under half-boiler power she made 9·053 knots; revolutions, 45. The engines and boilers worked in a very satisfactory manner, and the speed attained was half a knot more than on the former trial. On the 17th ult., at 5.15 p.m., when the *Pelorus* was 320 miles south-west half west of the Lizard Point, the chief engineer, Mr. James W. Steil, reported to the captain that the foremost starboard boiler was red hot, and that the felt over it was on fire. That part of the maindeck immediately contiguous was at once scuttled in two places, so as to allow water to pass on and behind the boiler, and a plentiful supply being sent down from the pumps and by buckets from over the side, the boiler was completely cooled by 9 p.m. One of the stokers first discovered the accident by the smell from the burning felt. The crowns of the furnaces have dropped, and the boiler is so much injured that it will have to be removed, which will be done at once.

The Screw Steamship "Gibraltar," 81, Capt. J. C. Prevost, recently put in commission, made an experimental trip outside Plymouth Breakwater, on the 2nd ult. Six runs made at the measured mile, under full boiler power, gave a mean speed of 10·897.

Lumley's Rudder.—The *Columbine*, 4, screw sloop, was docked on the 10th ult., at Portsmouth, in course of her refit preparatory to proceeding to the Pacific. An opportunity was thus afforded to examine the jointed or "Lumley" rudder with which she was fitted some months since at Sheerness. No part of the rudder or its chain is worn or strained in the slightest degree, but is all as perfect as on the day it was first fitted. The *Columbine* has just returned from the coast of Scotland, where she has experienced a considerable amount of rough weather both under steam and canvas, during which the rudder has been tested in every possible way. With the vessel under canvas it was found an angle of tiller of eight degrees was sufficient to put the ship about. In ordinary steering, more especially under steam, a very small touch of the helm was found sufficient. In entering and leaving the docks at Aberdeen, where the entrance is very narrow and the turnings sharp, the pilot on board was surprised to find that Commander Ward intended to trust to his vessel's rudder alone in taking her in and out of the docks.

The "Falcon," 17, screw-corvette, completed her course of trials, prior to commission, at Portsmouth, on the 13th ult., under the supervision of the officers of the steam factory and reserve. She is 751 tons measurement, and is driven by a pair of auxiliary engines of 100-horse collective, nominal, power. There was a strong breeze from the southward, which rendered some of her runs over the mile against wind and tide of unusual length, and therefore detracted from the ship's average speed. She made one mile under such circumstances, when trying her speed with half-boiler power, in 18 minutes and 37 seconds. The *Falcon* is rigged, armed, and stored for sea, and only waits her crew and ammunition to complete her to her sea-going draught of water. At the commencement of her trial, she drew 14ft. 2in. of water forward, and 14ft. 5in. aft. The load on the safety valve was 20lb., and the vacuum ranged from 23in. to 24in. Six runs were made with full boiler power, the mean of which gave the ship a speed of 8¾knots. Four runs were made with half-boiler power, and the mean of these gave a speed to the ship of 6·250 knots. Two circles were made to port and starboard with full power in 5 min. 9 sec. and 4 min. 56 sec. respectively; and at half-power the two circles were made in 6 min. 30 sec. and 6 min. 54 sec.

The United States' Ram "Dunderberg."—The following are some of the dimensions, &c., of this vessel, built by Mr. W. H. Webb:—Extreme length, 378ft.; extreme breadth, 68ft.; whole depth, 32ft. The whole upper surface is to be iron-plated to six feet below the water line. Above the deck she has a large casemate to carry ten heavy guns, and above these are to be placed two revolving turrets. To form her enormous ram the bow of the vessel is solid wood, running back over fifty feet. This is to be plated with the best quality of iron. The sides of the vessel, before the plating is put on, are solid oak wood. She will have two rudders, which are protected by the peculiar construction of the overhanging stern. Her engines will be 6000 horse-power; and, to give stability to the hull at all times, and especially at the time of impact, when ramming a vessel, she is provided with one main and four sister keelsons, which run the entire length of the vessel and meet at either end. These are of solid oak. The entire frame of the vessel is diagonally strapped with iron, which gives her great strength. At some distance from the side of the vessel inboard is a ceiling or skin which furnishes a large number of store-rooms, and at the same time makes a water-tight compartment the whole length of the vessel. She has three decks, or, counting the bombproof deck of the casemate, she is a four-decker. The lower decks are of the same thickness as ordinary vessels; but the casemate deck is much heavier, while the bombproof deck over the casemate is twenty-one inches thick of wood, with two inches of plating to cover it. The casemate is 163ft. long in the clear, and it extends the entire breadth of the vessel. Its sides are sloping, and over three feet in thickness. This fort upon deck is pierced for ten heavy guns—three in each broadside, and two at each end. Surmounting this are to be two turrets twenty-four feet internal diameter and fifteen inches in thickness. Her armour-plating alone will weigh over 900 tons, while her turrets, pilot-houses, &c., will weigh over 300 tons; so that at a rough estimate the weight of armour she will carry will not be far from 1300 tons. The large

casemate "tumbles in," or inclines inward, at an angle of nearly forty-five degrees; so that it is not necessary to have the iron so thick as may be supposed. The wood backing, which makes a cushion for the armour plates, is much thicker than has ever been used before in a plated vessel, so that in the event of the angular sides of this casemate being struck and the iron penetrated, there is an enormous quantity of oak and pine wood yet remaining to be pierced. The plating of the hull is put on in upright slabs, and not horizontally, the plates varying in length from eleven to twelve and a-half feet, and twenty-eight inches in width. These slabs are three and a-half inches thick, and are secured to the vessel by means of a peculiar screw bolt. The plating of the casemate is four and one-half inches in thickness, from eleven to twelve and one-half feet in length, set upright, and twenty-eight inches in width. At the bottom of these plates and the top of the hull plates they are bevelled so as to form a snug joint. The turrets are built in sections or slabs, which are five inches thick, eleven inches high, and nineteen feet in length. These are bent so that it requires four of these slabs to make the circle. The inner courses of the turrets are two one-inch plates, and outside of the slabs are six courses of one-inch iron. Each turret is nine feet in height. The inside diameter of the turrets is twenty-four feet. All of the iron used in this vessel is of the best quality of hammered cold blast charcoal iron, and comes from the Reading Forge.

LAUNCH OF THE "RE DOM LUIGI DI PORTOGALLO" FOR THE IRON-CLAD ITALIAN NAVY.—Mr W. H. Webb, of New York, United States, launched the new frigate *Re dom Luigi di Portogallo* for the Italian navy. The vessel is a sister ship of the *Re d'Italia*, which was launched from the same yard on the 18th April. She is 295ft. in length, 55ft. beam, 30ft. 6in. depth of hold, and 5500 tons, carpenter's measurement. Her build does not materially differ from ordinary vessels of war, except that from the water-line upwards she falls in considerably, so as to give an angle to shot. Her frame is of the best white oak, and put together with iron strappings, which render her one of the best constructed vessels ever built by Mr. Webb. The gun deck has ports for seventeen guns. On each side the portholes are of a peculiar shape, being very narrow and bevelled inward, like the embrasures of a fort. Her engines are building at the Novelty Iron Works, and are direct back action, with eighty-four inch cylinders and forty-five inch stroke. She has six horizontal tubular boilers, with thirty-six furnaces. She will be propelled by one composition propeller. The propeller can be hoisted out of the water when it is desired to make a passage under canvass alone. She will be bark rigged, and will not look unlike the United States steam frigates of the Wabash class, except she will have no yards on the mizenmast.

THE LAUNCH OF THE "VALIANT," from the yard of Messrs. Westwood, at Poplar, took place on the 14th ult. The *Valiant* is a connecting link, so to speak, between the *Warrior* and vessels of the *Defence* and *Resistance* class. Her length over all is 280ft., her extreme breadth, 56ft., and her depth from her spar deck, 39ft. Her lines are finer than the broad bowed vessels like the *Defence*, but yet are not to be compared in fineness to the *Warrior*, while, on the other hand, her bows, without having a regular beak to be used as a ram, are still sufficiently projecting beneath the water line to enable her if she got a chance of striking an enemy to inflict fearful mischief, without risking the safety of her own hull. She may be called a sister ship to the *Hector*, which was launched from the Clyde at the close of last year. In the construction of the hull the principle is the same as that of all the iron frigates. Like the new frigates, however, she is to be plated from stem to stern in armour, the stern being almost as fine as her bows, and with an additional plating of iron over her outer stern-post and rudder head. About 80ft. from the bows inboard she is fitted with a semi-circular shield, which extends from one side of the vessel to the other, and rises from the main deck to the level of her bulwarks on the spar deck. This is coated with 4½in. armour plates, and lined with teak as with the broadside. On the main deck it is closed, but on the upper is pierced for two of the heaviest guns for use in chasing an enemy, or when bearing down on one to strike her as a ram. It is intended that the *Valiant* shall be fitted with a pair of horizontal engines of 800 horse nominal power, on the double piston-rod principle, manufactured by Messrs. Maudslay. The cylinders are each to be 82in. diameter, with a stroke of 4ft. They will both be surrounded with steam jackets, which are supplied with steam direct from the boilers; the ends of the cylinders and the cylinder covers are also to be cast hollow and supplied with steam in the same manner. The screw propeller is 20ft. diameter, with two blades, constructed so that the pitch can be varied from 22ft. 6in. to 27ft. 6in. When working full power the engines are expected to make about 60 revolutions per minute. There will be six boilers placed, three on either side of the vessel, with the stoking-room between them. There will be also a pair of auxiliary engines of the collective power of 40 horses, to work two double acting force pumps, arranged with a system of pipes throughout the vessel for the purpose of extinguishing fire. These engines will be also used for driving two fans for ventilating the cabins by means of two lines of pipes, ranged one on either side, throughout the length of the vessel, with gratings for regulating the supply of air into each compartment. These engines will also be used for driving a blast for a cupola furnace, for melting iron for shells, placed at the end of the stokehole, and for driving an apparatus for raising the ashes on to the upper deck, so as to save labour. Externally the *Valiant* looks as ugly as the *Hector*, though better in the water than either the *Resistance* or *Defence*.

NEW GUNBOATS.—At Chatham a notification has been received that the Admiralty have decided on constructing a squadron of iron gunboats, to take the place of those wooden gunboats which have been sent round from the Medway to Deptford Dockyard to be broken up. The new gunboats are to be constructed on an entirely new system, from plans proposed to the Admiralty by Mr. Reed, the Chief Constructor of the Navy. They will be armour-plated, and will be driven by twin screw propellers, each boat being adapted to carry two heavy Armstrong guns. The design of the proposed gunboats is at present being worked out at the Admiralty, and as soon as the plans have been finally adopted the construction of the proposed squadron will at once be commenced.

THE TRIAL TRIP OF THE "SALAMIS," paddle wheel yacht steamer, 835 tons, 250 horse-power, took place on the 23rd ult., at the measured mile off Maplin Sands. At her former trial the *Salamis* drew 9ft. 2in. forward, and 9ft. 10in. aft. With 120 tons of coal and nearly the same quantity of stores, shot, cable, water, Armstrong, and other guns, she on this occasion drew 10ft. forward, and 9ft. 11in. aft, and was therefore not in the best possible trim for making her trial. The immersion of the paddle wheels from the inner edge of the floats was 8in., and the total dip 4ft. 2in. She is fitted with Morgan's patent feathering floats, which materially increase her speed. The diameter of the paddle wheels is 21ft. 6in. The engines, which are by Messrs. Ravenhill, Salkeld, and Co., are fitted with all the latest improvements, including superheaters, &c. Six runs were taken at full boiler power, with the following results:—In the first run the time was 3 min. 54 sec., speed in knots 15·385, and number of revolutions 30½ per minute; in the second run the time was 5 min. 6 sec., the speed 11·765 knots, and the number of revolutions 33; in the third run the time was 3 min. 52 sec., the speed 15·517 knots, and the number of revolutions 34; the time in the fourth run was 4 min. 42 sec., the speed 12·766 knots, and the number of revolutions 34; in the fifth mile the time was 4 min. 3 sec., the speed 14·815 knots, and the number of revolutions 34; in the last mile the time was 4 min. 35 sec., and the speed 13·091 knots. The mean vacuum was 26, and the average temperature of the stoke-holes 90 deg., and of the engine-room 78 deg., during the trial. The average speed attained by the *Salamis* during the six runs was 13·84 knots,—that is to say, 16 statute miles per hour. This is exactly a knot an hour less than on the occasion of the former trial of this steamer, when she attained a mean average speed of 14·843 knots an hour. This falling off in her speed is to be attributed to her uneven trim, the vessel being down more by the head than the stern; the heavy nature of her rigging, masts, and spars, which operate disadvantageously to the speed of the steamer; and, lastly, to the foul state of her bottom, from the lengthened time she has been in harbour. At the close of the trials at full speed two of the boilers were cut off, and a couple of runs taken over the measured mile at half-boiler power with the following results:—First run—time 4 min. 40 sec., speed in knots, 12·857, and number of revolutions 30; second run—time, 5 min. 2 sec., speed 11·921 knots, and number of revolutions 12·389. giving a mean speed at half-boiler power of 12·389 knots per hour, as against 12·648 knots per hour at half speed on the occasion of her former trial on the 21st August. From these figures the *Salamis* is out of proportion a much faster vessel under half-boiler power than when steaming at full speed, the difference in the two rates being less than a knot and a half an hour. During the trial, Admiral Bullock was busily employed on board in making experiments with and recording the results of the trials with his new description of log for enabling the speed of ships at sea to be instantaneously ascertained. The apparatus used for the purpose is a kind of steelyard, which is suspended from the vessel's taffrail, and attached to which is a line of some 150ft. in length with the log at the end. The pressure on the hand of the dial causes it to revolve, and a series of numbers on its face will indicate the true speed of the vessel at any moment. The *Salamis* was placed in the first division of the steam reserve in readiness for any service for which she may be destined.

NAVAL APPOINTMENTS.—The following appointments have taken place since our last:—J. L. Rastrick, of the *Miranda*, promoted to acting First-class Assist. Engineer; W. Stretton, Assist. Engineer, to the *Scylla*; J. Anderson, of the *Indus*, H. Aitken, of the *Edgar*, G. Boyd, of the *Asia*, E. C. Legh, of the *Dauntless*, J. King (b.), of the *Havock*, J. Watson (b.), and R. Blackwood, supernumeraries of the *Indus*, and C. E. Uffindell, supernumerary of the *Fisgard*, promoted to First-class Assist. Engineers; J. M'Master, of the *Vulcan*, T. Russell, of the *Tartar*, G. O'Brien, of the *Rapid*, D. Grant, of the *St. George*, James Jack, of the *Aboukir*, T. N. Crowder, of the *Jason*, and D. Ferguson, of the *Nile*, promoted to acting First-class Assist. Engineers; E. Lilley, Engineer, to the *Indus*, for the *Cordelia*; T. Pattison, of the *Hornet*, promoted to First-class Assist. Engineer; J. Rimnals, Assist. Engineer, to the *Indus*, for the *Gladiator*; J. C. Gauchy, Chief Engineer, to the *Tamar*; F. T. Elliott, Engineer, to the *Cumberland*, for the *Fawn*; J. F. Channon, Engineer, to the *Tamar*; F. W. Henderson, Assist. Engineer, to the *Cumberland*, for the *Sepoy*; G. Tidcombe, F. Pursell, and J. Milne, Assist. Engineers, to the *Tamar*; T. Stanley, Assist. Engineer, to the *Asia*, as supernumerary; H. Griffin, Assist. Engineer, to the *Fisgard*, as supernumerary; J. E. Callagan, Assist. Engineer, to the *Indus*, as supernumerary; C. Moore, Chief Engineer, to the *Fisgard*, for the *Valiant*; J. Bonney, Chief Engineer, to the *Cumberland*, for the *Clio*; J. V. Thompson, First-class Assist. Engineer, to the *Rattlesnake*; J. H. Wills, Assist. Engineer, to the *Cumberland*, as supernumerary; J. F. Channon, Engineer, to the *Fisgard*, as supernumerary; W. Todner, Engineer, to the *Tamar*; J. Downes, Engineer, to the *Cumberland*, for the *Bullfrog*; J. Rice, Engineer, to the *Indus*, as supernumerary; T. S. Gissing, Engineer, to the *Falcon*; P. Murray and H. Thomson, Assist. Engineers, to the *Falcon*; J. Watson (a.), of the *Espoir*, promoted to Acting First-class Assist. Engineer; J. Leys, J. A. Burton, and J. W. German, Chief Engineers, to the *Cumberland*, for the *Achilles*, *Bombay*, and *Amphion* respectively; G. H. Weeks and H. W. Fitzgerald, Assist. Engineers, to the *Asia*, as supernumeraries.

MILITARY ENGINEERING.

IMPORTANT TRIAL OF ARMOUR-PLATES.—The trials of 5½-in. armour-plates on the side of the *Monarch* target ship at Portsmouth were attended with an unusual degree of interest, owing to the fact of their being the first time the four leading firms in England had supplied plates of equal thickness of metal for trial. They consisted of one each from Messrs. John Brown and Co., of Sheffield, the Mersey Iron and Steel Works, the Thames Ironworks and Shipbuilding Company, and the Millwall Company. All four were good plates, but with varying degrees of excellence. Messrs. John Brown and Co.'s plate was the best of the four. Four shots struck this plate in a vertical line, but they opened no cracks in the same direction nor otherwise, except in the indents. Two of these shots overlapped each other 3in., but the result of the two blows only produced an indent of 2½in. in depth—an unprecedentedly favourable result, as showing the excellent resisting power of the iron. Eight shots struck within 3ft. of the left of the plate, and three of them on the very edge, but only produced the usual small cracks exhibited by the firm's plates within the circumference of the indents. No signs of concentric cracks were shown round the indentation of these edge blows. The Mersey plate received 13 shots in all, and stood very well for the "first" rolled plate produced by this firm. The metal has a soft appearance, and seemed of good quality, but there was a tendency in it to crack vertically—a fault which will, doubtless, be guarded against in further productions. The Millwall plate was not of so good a quality as the 5½in. plate previously sent in for trial by this firm. The welding was very faulty;—it received 11 shots. The Thames Company's plate was very severely injured by the 9 shots fired against it striking on the weakest points. Five struck in an area of 3ft. by 18in., and three of them joining in the circumference of indents. The effect, however, was only slight, though numerous cracks were made from the severe pounding the iron had received. The gun used was the ordinary 68-pounder, and cast-iron shot with 16lb. of powder, at 260 yards range. On the day following the trial of the plates a smooth-bore 100-pounder gun was shipped from the *Excellent* on board the *Foam* gunboat, and the latter vessel proceeded up the harbour, and took up a 200 yards' position from the target-ship and the plates she had fired at with her 68-pounder of the previous day. A shot was fired at each plate with a 25lb. charge of powder, and in all but one instance the damage inflicted appeared to be commensurate with the increased weight of the shot and size of the charges, as compared with the 68-pounder. A further careful inspection hardly confirms this belief. In all but one instance the plates had been damaged by previously firing from the 68-pounder, and no fair inference could, therefore, be drawn from the results. In the one instance referred to the Millwall plate was struck fairly in an uninjured part by the round 100-pound shot, and the result was—diameter of indent, 10in.; depth of indent, 3in. There were cracks across the centre of the indent. The average diameter of the indent from the blows of a 68-pounder is 2in., with a depth of 2¾in. The *Monarch* is now having plates bolted on her sides for further experimental firing, including a trial plate for the *Research* from the Butterly Company, and one from the Thames Company for the *Minotaur*.

TRIAL OF ARMOUR PLATES, STEEL GUNS, &C., AT ST. PETERSBURGH.—Some trials have recently taken place at St. Petersburgh with the experimental 9-inch rifled cast steel gun. This gun is of solid cast steel, made by Krupp, and throws a 300lb. shell or a 450lb. solid shot. The results of some previous experiments with this gun led the Russian Government to order fifty of them, which are now in course of delivery. The principal object of the experiments on this occasion was to ascertain the best description of shell, and to test the quality of armour plates supplied by Messrs. John Brown and Co., of Sheffield. First, a series of cast-iron shells, 300lb. each, were fired at different ranges, and then shells made by Krupp were fired at the 4½-inch armour plates. The first shell, of hard cast steel, was 22½ inches long (two and a half diameters), with a flat end four inches in diameter. Fired with 50lb of powder at 700ft distance it passed through the plate, oak and teak backing, and broke into many pieces, although filled with sand only. The second and third shells were also of Krupp's steel, the same length, but with 8½" ends. Those shells pierced plates, wood, &c., and also went to pieces, although only filled with sand. The fourth shell was made by M. Poteleff, of puddled steel, on Aboukoff's system, the same dimensions as the second and third, and went through iron, teak, &c., but was only bulged up from 9" to 12", and the end flattened, not a single crack being visible in the shell. The fifth shell, the same as the fourth, passe

through iron, teak, and the second target, and went at least a mile beyond. The sixth and seventh shells were from Krupp, and were charged with powder; they were quite flat-ended, 9″ diameter. One exploded in the plate, the other in the wood. The eighth and ninth shells were of cast-iron, and although they passed through the plates, were of course destroyed. Evening prevented further trials, which will yet be made on the same plate. The results on the plate were highly satisfactory. In a space of 4′ 6″ × 3′ 6″ eight holes were made without any crack of the slightest description; and the marine officers present were highly satisfied, because they are obtaining 4000 tons of plates from Messrs. John Brown and Co. for their different ships.

STEAM SHIPPING.

The "Great Eastern."—The Committee of the Great Ship Company, in their report, recommend that the ship be placed on the longest voyages, where there can be the least competition and highest receipts, and that the shareholders contribute for the liquidation of the existing debts, rather than sell the ship at an enormous sacrifice. The gross outlay of the company, for the three and a half years, has been £278,259, the ship having been only 200 days at sea, whereas, had she been running on the Australian route, she would have been 450 days at sea, and the expenses would have been much less, except for coal. The gross receipts have been £153,000, while the receipts from five Australian voyages would probably more than treble this amount, the balance affording an ample profit to pay the shareholders. The report was adopted.

The Trial Trip of the "Resolute," one of the most powerful steam tugs in the kingdom, took place at Liverpool, on the 5th ult. The *Resolute* has had new boilers put in her, machinery overhauled, and refitted, new feed heaters put in, and rigged to make the voyage out to Calcutta, where she will make an addition to the Hooghly Steam Tug Company. During the trial trip of 54 nautical miles, which was performed in four hours, the engines worked most successfully, there being no heated bearing, the supply of steam being abundant, and the temperature of the feed water raised to nearly boiling point. The effect of the recent improvements, which were executed by Messrs. J. Jones and Sons, of Liverpool, has been to reduce the consumption of fuel from 30 to 18 tons per day, while the speed of the vessel has been considerably increased.

Trial of the Steam Tug "Columbus," at Liverpool, took place on the 14th ult.; and, notwithstanding she was heavily laden with coals and stores for her voyage out to Calcutta, she made 12 knots per hour. The *Columbus* is to form an addition to the fleet of tugs already sent out to the river Hooghly from Liverpool.

The Trial Trip of the "Lucy," steel plate built steamer, has taken place at Liverpool, under the superintendence of the surveyors to the underwriters' registry. During the trial, notwithstanding a strong wind and tide against her, she maintained a speed of 15½ knots. The pressure of steam was about 30lb., and the revolutions about 36. The results were considered highly satisfactory.

The Launch of the "Andalusia," screw steamer, from the yard of Messrs. Swan and Co., Maryhill, on the Clyde, took place on the 14th ult. She is of 400 tons burthen, and is to be employed in the Spanish trade. Her engines will be supplied by Messrs. Forrest and Barr, Port Dundas, Glasgow.

The Trial Trip of the "Sea King," iron framed and wood planked steamship, launched by Messrs. A. Stephen and Sons, for the direct trade between China and London, has taken place. The vessel made the run between the Cloch and Cumbraes, on the Clyde, at a speed of 12·25 knots per hour down, and up, against a strong gale of head wind, at 9·89 knots, a result highly satisfactory, considering the small power of engines to the size of the ship.

Steamship Building on the Clyde.—Messrs. Randolph, Elder, and Co. have completed the *Chile* for the Pacific Steam Navigation Company; she is the first of three large steamships ordered by the company from the same firm. The *Chile*, which has been fitted with double cylinder engines of 400 horse-power, left the Mersey on the 15th ult. to take her station on the company's main line between Panama and Valparaiso. In running from the Clyde to the Mersey she attained a mean speed of 13½ miles per hour against a strong tide, her engines working with an average pressure of 20lb. of steam, and making 21 revolutions per minute. Annexed are the dimensions of the *Chile*, which is 1600 tons burden:—Length between perpendiculars, 265ft.; beam, 36ft.; depth, 24ft. Messrs. M'Nab and Co. have launched from their yard near Albert Harbour, Greenock, a screw steamer of 340 tons, named the *Beatrice*, and built for the Bristol and Cork Steam Navigation Company. She will be provided with engines of 60 horse-power by Messrs. M'Nab. A fine ocean screw of 2000 tons burden, completed by Messrs. W. Denny and Brothers, of Dumbarton, has made a trial trip, at which she attained a speed of 13 miles per hour, her engines working with great smoothness. The *Infanta Ysabel* is to be employed as one of the Spanish Royal Mail steamers between Cadiz and Havannah. She is a sister ship to the *Principe Alfonso*, built recently by Messrs. Denny for the same undertaking, and her dimensions are as follows:—Length, 270ft.; breadth, 33ft.; depth to spar deck, 27ft. Her engines are of 400 horse-power, and she has state rooms for about 350 first and second-class passengers, in addition to accommodation for a large number of steerage passengers. Messrs. A. and J. Inglis have completed two steamers for Australia. The first is a paddle of 800 tons burden, named the *City of Brisbane*, built for the Australian Steam Navigation Company, and intended to trade between Sydney and Brisbane. The dimensions of the *City of Brisbane* are as follows:—Length of keel and fore-rake, 230ft.; breadth of beam, 27ft.; depth, 13ft. 6in. She will be propelled by oscillating engines of 250-horse power, her paddlewheels will have feathering floats, and her boilers will be fitted with superheating apparatus. The other steamer, the *Wallabi*, is intended for the Australian coasting trade. Her length of keel and fore-rake is 105ft., her breadth of beam is 18ft., and her depth of hold 7ft. She is of 162 tons burden, and her engines, which are of 30 horse-power, were fitted before she was launched. She will proceed to her destination under canvas, and will take out, in pieces, a screw steamer similar in dimensions to herself. Messrs. Scott, of Cartsdyke, have launched the *Lafayette*, another of the great ocean steamers which they are building for the Compagnie Générale des Paquebots Transatlantiques. The *Lafayette* is 3400 tons builders' measurement, and her dimensions are as follows:—Length, 350ft.; breadth, 45ft.; depth, 33ft. She has four decks, the upper one being flush from stem to stern. The three lower decks have each a height of 7ft. 3in., and the steamer will accommodate 330 first-class passengers, and will have capacity for 1000 tons of goods, besides stowing 1500 tons of coal in her coal bunkers. Her machinery is being fitted by the Greenock Foundry Company, and will consist of a pair of side-lever engines of 850 horse-power nominal. The cylinders are 7ft. 11in. in diameter, and 9ft. 6in. stroke. Steam will be supplied from four tubular boilers, each weighing 61 tons; each sole plate weighs 55 tons, and the paddlewheels will be 37ft. 6in. in diameter. The *Lafayette*, which is the largest steamer ever built in Greenock, is a sister vessel to the *Washington*, launched in June. A third steamer in course of construction on the Clyde for the company's line will be ready in December, while five other equally large steamers are being built by Messrs. Scott, with French workmen, at St. Nazaire. Messrs. Swan and Co., of Maryhill, have launched the *Andalusia*, a screw of 400 tons, built for Messrs. Mories, Munro, and Co., and a consort for the *Colina*, lately completed by the same firm. Both steamers are intended for the Spanish trade. The *Andalusia* is now receiving engines by Messrs. Forrest and Barr.

The Screw Steamer "Beatrice," above referred to built and engined by Messrs. M'Nab and Co., in her trial trip ran the lights of the Clyde at a speed of 10½ knots.

The Screw Steamer "Maria Pia," built by Messrs. John Reid and Co., Port Glasgow, for the Lusitania Steam Navigation Company, Lisbon, having had her machinery fitted on board by Messrs. M'Nab and Co., Greenock, recently underwent her trial trip, and ran the distance, between Greenock and Knock Castle, at a speed of 12 knots per hour.

TELEGRAPHIC ENGINEERING.

The Telegraph Cable from Algeria to Spain.—It is stated in 'the *Annales Télégraphiques*, that the French Government has arranged with Messrs. Siemens and Halske, of Berlin and London, for the supplying and laying of a telegraphic cable between Oran and Carthagena, or another port on the coast of Spain. This distance is about 108 nautical miles, the greatest depth about 1420 fathoms. The cable will be a fac-simile of the one exhibited by Messrs. Siemens at the International Exhibition, 1862.

Persian Gulf Telegraph.—On the 19th ult. her Majesty's ship *Tweed*, laden with the last consignment of the telegraphic cable about to be laid down over a length of 1200 miles from the mouth of the Persian Gulf along the sea coast to Mekro, left the works of Messrs. Henley and Co., the contractors and manufacturers, at North Woolwich.

The Electric Telegraph Company's submarine communication with the Isle of Man has been restored, and messages can now be forwarded to Douglas, Peel, and Ramsey.

RAILWAYS.

Great Western Railway.—It appears that the directors of this company are about allotting to the shareholders, in rateable proportion to their holding, 4½ per cent. perpetual irredeemable preference shares to the amount of £1,227,562. They state that it will not create any fresh or additional charge upon the revenues of the company, being issued in substitution of monies borrowed from bankers and others in the form of temporary loans, renewable at short periods. Though the state of the money-market and the credit of the company have enabled the directors to borrow this money at 4 or 4½ per cent., yet the commission and other expenses of frequent renewals have increased the yearly charge to an amount more than equal to 4½ per cent. So then, when taken up as proposed, the interest payable upon that amount will be rather less than it has hitherto been, and the company will thus be secured against all contingencies in respect thereof. The allotment will be in the proportion of one new share of £10 for every £100 ordinary stock or shares in the company. The shares will be treated in respect of dividend as fully paid up from the 29th ult., being equivalent to a bonus of £2 per cent. A discount at the rate of 4½ per cent. per annum is to be allowed on any instalments paid in advance.

The East Indian Railway will be open to the public from Delhi to Calcutta on the 1st of February next at the latest, with the exception of crossing the Jumna at Allahabad. Orders have already been given for compiling the new time tables, and for making the other arrangements requisite for the increased length. As a temporary measure, the railway will either have a pontoon bridge over the Jumna or a steamer to convey the traffic across the river.

The Lyons and La Croix Rousse Railway.—In a paper lately read before the Paris "Société des Ingénieurs Civils," M. Molines gave a description of this railway, from which the following is an extract:—The total length of this railway is only 535 yards, on an incline of 16 per cent., being a height of 85 6 yards. Owing to this enormous gradient, the trains are set in motion by means of stationary engines and ropes winding round drums, similar to the arrangement formerly in use on the Liege and Aix-la-Chapelle "Seilebene." Two stationary engines of 150-horse power each are employed, the one for passenger and the other for goods traffic; they have two cylinders, no condensation, and uniform expansion;—on account of the shortness of time of travelling (three minutes). The stroke of the pistons is 2 metres (6ft. 7in.), and they are connected directly with the drums, the diameter of which is 14ft. 9in., so that the speed of the piston is about half that of the rope. There is a "directing mechanism" for setting the rope properly upon the drum, and there are, moreover, two steam brakes. The feeding water is heated by the exhaust steam, by means of a superheating apparatus. The boilers are tubular, and work a maximum pressure of 75lb. each per square inch. The rope undergoes a tension of 9 tons; it is made of cast steel, of a thickness of 2⅓in. (6 centimetres), and was tried at a strain of 90 tons. The rolling stock consists of carriages with two floors, holding 108 passengers each; they are furnished with an improved kind of brake, which is self-acting, and stops the train at once in case of the ropes being broken. This is effected by an arrangement of counterweights, which are supported by springs and balanced while the rope is strained; but when the rope is broken they fall down and produce a friction sufficient to prevent the carriages going on.

Iron Railway Sleepers have been adapted on the railway connecting a colliery with the Couillet Iron Works, near Charleroi, Belgium, for a length of rail of about 450 yards. These sleepers are made of H shaped, drawn out iron, laid down horizontally, about 7in. wide, placed under the rails at distances of 3ft. 4in. from centre to centre, each sleeper having a length of 8ft. 2in. (2·5 metres), while the rails themselves are of the usual Vignole's shape, of a weight of about 25lb. per foot; the weight of the sleepers is about 31lb. The rails are fixed on the sleepers by means of two bolts, a cushion of oak being laid between both, in order to render the connection more elastic, and to allow of tightening the bolts. The railway on which these sleepers are used has a gradient of 1 in 100, and curves of less than 320 yards radius; it is travelled upon by four-wheeled engines of 20 tons weight, the weight being distributed upon the rails at the rate of 11 tons on the fore and 9 tons on the hinder axle. The sleepers have, answered remarkably well for twelve months, as shown by the engineer's returns.

The London and Brighton Terminus at London-Bridge.—Operations have been commenced by the London and Brighton Company for the accommodation of their increasing traffic at London-bridge, the station room at present existing there being found inadequate for the purpose. The widening of the main line leading into the terminus at London-bridge, together with the viaduct, about 100 feet wide and 2000 feet in length, leading up to the terminus, has been commenced by a large body of workmen, and others are engaged in demolishing the buildings bought by the railway company in St. Thomas-street, Webb-street, Broadway, and Maze-pond, Bermondsey, leading up to the Brighton terminus and International Hotels. Parallel with the viaduct a new street will be constructed between 300 and 400 yards in length, leading from the railway station into Bermondsey. There will be shops and warehouses underneath the viaduct.

A Grand Trunk Railway, 1858 Miles Long.—This line of railway starts from Missouri, passes through Kansas, cross the Sierra Navada Mountains, and terminates at tide water in Sacramento, California; thus opening up a direct railway communication across the North American continent from the Atlantic to the Pacific Oceans. The work, which is divided into three sections, has been commenced at both ends, and in a short time will be energetically pushed on in the centre. The eastern portion has been taken by a Kansas company, and already the line has been graded for over 300 miles from the junction of the Kansas and Missouri rivers going west; and by the end of the present year, if labour can be procured, the line will be completed, as far as the earthworks are concerned, entirely through the State of Kansas. The central portion, a distance of about 1000 miles, is the most difficult part; it crosses the Sierras at Summit Valley, at an elevation of 7027ft. above tide water level at Sacramento City, but the line has been so laid out that the steepest gradients do not exceed 105ft. to the mile—a rate of inclination several feet less than one of the lines passing through Virginia. The western slopes of the great mountain range have presented many difficulties. There are many rivers run-

ning through gorges from 500 to 2000ft. deep, with their precipitous slopes varying from perpendicular to an angle of 45 degrees. To avoid these the surveyors have run the line along the most unbroken ridges, and although somewhat extending its length will, it is said, only cross one river (the Little Bear river) of any magnitude. The eastern declivity is not so difficult, although there will be eighteen tunnels to drive, varying from 300 to 2000ft. each. Part of this section, or about 155 miles, will cost 85,000 dols. per mile. A special chartered company has been formed to construct this central portion, called the Pacific Union Company. They will be assisted to an extent of about 350 miles by the Mormons, should it be decided to make a short divergence of the line, so as to pass through Salt Lake City, in the Utah territory. The western territory is being constructed by a Californian company. They have already completed 60 miles of the road at the Sacremento end, and are now only waiting the arrivals of the metals from England to get it into running order. This section of the line passes through heavily wooded forests of fir, cedar, pitch, pine, oak, and tamarac, furnishing cheap and ample materials for sleepers, bridges, and buildings. The capital is 15,000,000 dollars, the estimated traffic returns are 4,000,000 dols. per annum, while the working cost is not to exceed 1,000,000 dols. If the work can be done within these figures, and their estimated returns realised, the stockholders may anticipate a dividend of about 25 per cent. This western portion of the line will speedily open up immense mineral wealth, now lying dormant for want of transportation. It is a well-known fact that there is at the present time large quantities of low grade silver ore being thrown aside that would pay for returning if some cheap means of carriage to the coast could be obtained, beside rich lead and copper mines in abundance. The cost of the entire line will amount to 90,000,000 dols., or £10,974 per mile.

RAILWAY ACCIDENTS.

RAILWAY ACCIDENT IN SPAIN.—A serious accident has occurred on the railway from Barcelona to Granollers. The bridge thrown over the Hahern having been undermined by the violence of the torrent, which had been considerably increased by the heavy rain, had suddenly given way during the passage over it of a railway train coming from France, composed of nine carriages. The locomotive and seven carriages were thrown into the river, causing a very heavy loss of life.

RAILWAY ACCIDENT AT PORT GLASGOW.—On the morning of the 9th ult., while the Belfast mail-train, which had been detained behind its usual time, was leaving Port Glasgow station on its way from Greenock to Glasgow, a goods engine with break-van attached came up at a great speed and dashed into the hindermost carriage of the train. There were seven persons in the carriage at the time, one of whom was killed, the rest being more or less seriously injured.

COLLISION AT KENSINGTON STATION, LONDON.—An accident took place on the night of the 11th ult., about twenty minutes past seven o'clock, just outside the Kensington Station of the West London Railway Extension. It appears that as the London and Brighton train, which leaves Kensington at 7.15 p.m., was in the act of issuing from the station, a few minutes behind its proper time, and while it was proceeding on a portion of the rails common to the Brighton and South-Western trains, it was run into by the South-Western train, which left Clapham Junction at 7.10 p.m., the latter being due at the Kensington Station a few minutes before the collision took place. The two trains were both running at a slow rate of speed, the two engines ran into each other with a crash, throwing the passengers from their seats.

COLLISION ON THE GREAT NORTHERN RAILWAY.—A collision occurred on the evening of the 1st ult., about nine o'clock, at the Huntingdon station of the Great Northern Railway, between an express and a coal train which resulted in a smash of the coal train, and the strewing of the line with broken trucks and tons of coal. The up coal train, it appears, arrived at the station about nine o'clock, and was followed by the up Manchester express, which is due at this station a few minutes before nine, and which usually passes by without stopping. On this occasion when the express train turned the curve of the line about a mile and three-quarters distant, in sight of the station, the distant signal showed danger, and the driver in consequence shut off his steam and allowed his train to approach slowly—in fact it almost came to a stand; but perceiving the near signal-light in his favour, he put on his steam with the intention of passing the station on his journey. The train had only arrived at a few yards beyond or at the end of the middle platform when it came into collision with the coal train, which had not yet shunted out of its way. The result of the collision was that the break-van of the coal train was smashed, and also two trucks containing coal. The engine of the express, one made expressly for the Great Northern for running long distances, mounted over the wheels of the break-van, and those wheels were firmly jammed beneath it. The broken fragments of coal-trucks and coals were scattered about the line for a considerable distance. The forewheels of the engine of the express train appeared to be the only wheels of that train not in their place on the metals.

ACCIDENT ON THE IRISH NORTH-WESTERN RAILWAY.—An accident, resulting in the injury of several parties, happened on the above line of railway, to the train which left Derry at one o'clock, on the 10th ult. The train proceeded as usual, and reached Fintona, which it left at 2.40. The train had proceeded but a short distance when the engine and train ran off the line, and fell over a precipice. Both engine and carriages were completely reversed by the accident. Fortunately, no lives were lost, but the engine-driver was much injured. The stoker was also severely bruised.

COLLISIONS AT HEATON CHAPEL AND GUIDE BRIDGE.—A collision, attended with serious injuries to several persons, occurred at Heaton Chapel, on the 23rd ult. The early market train from Manchester had reached the above place, and while standing it was run into by a single engine. One of the carriages was driven off the line by the force of the collision, and the guard received severe injuries. A fatal accident also occurred on Thursday night at Guide Bridge, with a cattle train from Liverpool to Peterborough. The train, by some means, became divided, when one portion, to which was attached a third-class carriage, with some drovers, was run into by a goods train from Ardwick for London.

ACCIDENT ON THE NORTH-EASTERN RAILWAY.—On the 20th ult., the boiler of the engine of the goods train, which left Leeds between eight and nine o'clock in the morning, on arriving at Arthington station, burst, and caused considerable damage to the goods warehouse, which is adjacent to the station.

BOILER EXPLOSIONS.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.—At the monthly meeting of this Association, held September 29th, 1863, the chief engineer presented his monthly report, of which the following is an abstract:—"During the past month there have been examined 319 engines and 471 boilers. Of the latter, 4 have been examined specially, 4 internally, 49 thoroughly, and 414 externally, in addition to which 1 of these boilers has been tested by hydraulic pressure. The following defects have been found in the boilers examined:—Fracture, 5 (2 dangerous); corrosion, 16; safety valves out of order, 2; water gauges ditto, 20 (1 dangerous), pressure gauges ditto, 10; feed apparatus ditto, 2 (1 dangerous); blow-out apparatus ditto, 14; fusible plugs ditto, 8; furnaces out of shape, 1. Total, 78 (4 dangerous). Boilers without glass water gauges, 3; without blow-out apparatus, 21; without back pressure valves, 17. Three boilers, not under the inspection of the Association, have exploded during the past month. One of the boilers has been personally examined since the explosion, while this was prevented in the other cases by distance. No. 30 explosion, from which one person was killed and two others injured, happened to an agricultural boiler, while at work at a farm, driving a thrashing machine. The boiler, which was about twelve years old, was a portable one, of the multitubular locomotive type, and was worked at a pressure of about 40lb. per square inch. It was stated at the inquest that the safety valve worked freely, and that there was a due supply of water, the explosion being attributed entirely to a defective plate in the fire-box, which had been eaten away by corrosion, until reduced to one-sixteenth of an inch in thickness. This plate had been previously repaired, and at the time of the explosion was cracked through, and though it had for some days been leaking in consequence, had yet been worked on in that state. The owner of the boiler was brought in guilty of manslaughter, the jury adding that they thought the appointment of a Government inspector to be highly necessary. No. 32 explosion occurred to a new Balloon or Haystack boiler during the operation of testing at the maker's yard. It had not been constructed for raising steam for purposes of power, but was intended to be used as a chemical evaporating pan or still. The boiler—as another of similar construction and dimensions had recently been—was proved with steam, in order to test the tightness of the joints. The pressure, which appears to have been about 50lb., being raised, not by generating the steam within it by means of a fire underneath, but by communication with another boiler in work, to which it was temporarily connected for the purpose. Some five or six men were engaged upon it in caulking the seams at the time of the explosion, four of whom were blown to a distance from it; one of them, who was killed upon the spot, being thrown upon the roof of a house about forty yards off, while two others died subsequently from the injuries received. The boiler was laid upon its side during the test, and gave way at the bottom, which was blown out entire, and thrown upon a roof about 10ft. high and 13 yards distant, the shell rearing up on its dome end and remaining in that position supported by a shear leg. Its dimensions were as follows:—The height was 11ft.; the dome, from the appearance of which the term Balloon boiler probably arose, was 9ft. 3in. in diameter, and the base 8ft. 9in., while the cylindrical sides were drawn in to 7ft. 9in. in the waist. The bottom, like that of a bottle, was concave, as is usual in these boilers, and rose 18in. at the centre, in order to enable it to resist the downward pressure, being connected to the sides of the shell by a 3-in. angle iron, half an inch thick. The plates, which were from seven-sixteenths to half an inch in thickness throughout, were, some of them, second-hand, those forming the dome being new, the remainder having been used in a boiler before. They had however been worked to their new shape, their edges sheared, and the holes punched afresh. The rivets, which were three-quarters of an inch in diameter, were centred from one and seven-eighths to two inches apart, and the general workmanship appeared satisfactory. The rent between the bottom and sides of the boiler had occurred, for the most part, at the lower ring seam of rivets in the cylindrical portion of the shell, but not altogether so, some portion of the rent running through the rivet holes at the outer edge of the circular bottom plate; while, from the upward position in which the latter was thrown by the explosion, it appeared most probable that the rent had commenced at that part of the boiler which lay nearest the ground at the time of the explosion, and thus, from the position of the fractures, must have started at the cylindrical part, and not at the bottom plate. The reason of this is not very apparent,—since there were two other ring seams of rivets in the cylindrical portion of the boiler which were quite uninjured, although subjected to the same direct pull, which, after allowing for the rivet holes, did not amount to two tons per square inch of metal; added to which, the longitudinal strain thrown upon these circular seams in cylindrical boilers, is only half of that which occurs in the transverse direction, so that it is difficult to account for the rent selecting the lower ring seam of rivets, or indeed for its occurring at all. Whether, however, the rent in question was due to some undetected flaw in the iron, or whether the plates had been crippled in being brought together, which is too frequently the case, or whether an unfair strain was caused by the springing of the bottom plate, which, although arched eighteen inches in the centre, was yet flat as compared with the hemispherical top, or whatever may have been the cause that started the rent, one thing is certain,—that the application of the hydraulic test would have detected and exposed the weakness, prevented the explosion, and saved the three lives.

BOILER EXPLOSION AT ARBROATH.—A boiler explosion, causing three deaths, took place on the 2nd ult., at the small flax spinning mill in Hume-street belonging to Mr. John Findlay. The mill is a one-storied building near the line of the railway, the boiler-house standing a little out towards the street, which is narrow. The work is situated in the very centre of the mill district of the town. The explosion occurred about seven minutes before six o'clock, the steam having been newly got up, but the machinery not being then in motion. At that hour a large number of workpeople, among them many girls, were passing along Hume-street to their employment in the adjacent works, and one of the girls was killed on the spot, and two others received injuries so severe that they died during the day. The boiler which exploded was 20ft. long, and 2ft. 6in. flue, and was what is known as a Cornish boiler, and was fitted up about eight or nine years ago by Messrs. Gourlay and Mudie, of Dundee. It was made of the best iron, and there can be no question as to the excellence of the metal originally. Until a short time before the explosion, the boiler was employed to drive an engine of 10 horse-power. At that time Mr. Findlay got one of 25 horse-power, which has been used only up to between 16 and 20 horse-power. The boiler was at the same time overhauled, the top part of the flue—the same plate as finally burnt—had been repaired on a former occasion. The body of the boiler remained entire, and was scarcely shifted from its position. The water gauge and steam indicator were not broken. The crown of the fire-box or tube was burst downwards, and fragments of the plate, which showed a bad fracture, and was slightly laminated, and which was 5-16ths of an inch thick, along with the furnace door and bars, were blown into the street.

ACCIDENTS TO MINES, MACHINERY, &c.

COLLIERY ACCIDENT AT COLEORTON.—On the morning of the 8th ult., about half-past eleven, an alarm was given that water had broken into the Califat, one of the Coleorton pits, the property of Messrs. Worswick and Walker. The men rushed to the pit's mouth, and many were drawn up. The rapid rush of the water, however, prevented all from reaching the spot, and six men perished. It appears that about three o'clock in the morning water was perceived coming through a side of one of the stalls in the workings, and between six and seven it was increasing so that several of the men refused to go to work, but upon an assurance being given that all was safe and that, if it increased, an alarm would be immediately given, all went to work. A carpenter, who lost his life, was sent down to plug the holes through which the water was flowing, but about half-past eleven the siding gave way, and the water rushed in with the greatest impetuosity. Fortunately there was a reservoir which received a large quantity of the water before reaching the bottom of the shaft, which gave most of the men time to ascend before it was upon them.

A COLLIERY EXPLOSION IN SOUTH WALES occurred on the 17th ult., at the Morfa Colliery, Margam, Glamorganshire, causing the death of thirty-five people. The Morfa Colliery (in which two previous accidents have occurred) is situate about eight miles from Neath. It is the property of, or situate on the estate of, C. R. M. Talbot, Esq., M.P., and lord lieutenant of the county, but is leased to and worked by the Messrs. H. Hussey Vivian, M.P., and Sons, Mr. Pendarvis Vivian being the resident manager. The Morfa Colliery is one of the largest in South Wales, and, generally speaking, there are about 800 colliers engaged in the pit, which works between 600 and 700 tons of coal per day, which is shipped at Port Talbot, Neath, and Swansea. The colliery is known as a "fiery" one, has literally miles of underground workings, is ventilated by means of a furnace with two

shafts for the down and return air, and is always worked with locked safety lamps. The explosion occurred about half-past ten in the morning. There were about 400 men in the pit at the time, but the effect of the explosion was confined to the Old Mine Foot Vein, where 43 men and boys were at work.

GAS SUPPLY.

Production and Generation of Gas.—Mr. J. C. Jeffcott, of Cork, has patented some improvements in the production and generation of gases, and also in apparatus connected therewith. The object sought to be obtained in the production and generation of gases by the invention consists chiefly of utilising the heat not used, or which escapes without being used, in steam or other furnaces and fire-places of every description. The means to do this consists of introducing into or placing within the furnaces or fire-places vessels of various forms, according to the construction of said furnaces or fire-places, so as that the said heat may be used; these vessels, retorts, or chambers must be formed and placed and correspond with the form of the furnaces or fire-places now in use, or to be used for this or other purposes. The form to be generally used will consist of a retort or retorts to be placed lengthways or at the sides, or as may best suit the fire-bars of the different fire-places; these retorts or other vessels will have mouth-pieces or other close covers, so as to be air-tight, and through these mouth-pieces or covers are to be introduced the animal, vegetable, or mineral substances from which the different gases are to be obtained, by their cohesiveness being destroyed by the heat before referred to, and not hitherto used for that purpose. The gases, after being set free in the retorts, chambers, or other such vessels, are then conducted by pipes in the way usually done, and applied to and for the different purposes for which they are now used. He likewise claims to be the inventor of a new description of furnace for these purposes, to be entirely composed of wrought or cast metal, and this consists of—first, a fire-place, with fire-bars on which the combustibles or heating substances are to be placed, the chamber, retorts, or vessels for holding the different materials rich in the different gases; these chambers, retorts, or other vessels to have the mouth-pieces for introducing the substances to be used, and then another casing to be placed over the entire, so that the heat may be prevented from escaping when the gases are disengaged, to be conducted by pipes in the usual manner. Lastly, Mr. Jeffcott purposes a new system of lighting and heating railway carriages, and the different railway stations along the different lines; he effects this by an apparatus first composed of a cast-iron or clay retort placed in the furnaces of the locomotive, and the gas obtained from coals and distilled in the retort by the heat of the fire then being used for generating steam is conveyed by pipes or tubes composed of metallic substances, or of India rubber, gutta percha, or other flexible materials, to the tank and gasholder containing the purifying water, as aforesaid, attached, annexed, or placed near the engine; it is then conveyed by tubes or piping to the carriages, and by the action of the gas when ignited on metallic plates, or the agency of a gas stove, the compartments of the carriages are heated and lighted. On the arrival of the engines at the stations along the line the gas already distilled and placed in the gasholder attached to the engine, as aforesaid, is conveyed by pipes to a gasholder erected at the station, when it is ready for use.

Gas at Nottingham.—The prospectus of a limited Nottingham and District Gas Consumers' Company has been issued. The capital will be £100,000, in £10 shares, deposit 10s. a share. The company has been projected by large consumers for the purpose of supplying the town of Nottingham and the surrounding district with gas of a purer and more brilliant character, and better adapted for manufacturing and domestic purposes, than that hitherto supplied; and at as low a charge as is attainable by the adoption of the most recent improvements in its manufacture, and consistent with a fair return for the capital employed. Calculations have been made that, charging for gas at a great reduction on the present scale, a dividend of £8 per cent. will be realised upon the shares; and although the maximum rate allowed by Parliament is £10 per cent., it is proposed to pay all money beyond £8 per cent. in aid of such rates in the town as may be afterwards determined upon.

Large Gas-holder at the City Gas Works.—For some time past numerous workmen have been engaged in erecting a vast gas-holder at the premises of the City of London Gas Company, Whitefriars. It is a three-light gas-holder, and has (except the painting) lately been completed. The works connected with it have been carried out by Messrs. Westwood and Wright, of Dudley, gasholder builders. When full it is of the great height of 100ft. (the highest ever built). Messrs. Westwood and Wright are now engaged in constructing extensive works at Para, in Brazil, which are rapidly progressing.

Treating Gas obtained from Coal and Mineral Oils.—Mr. J. Leigh proposes to subject the gas obtained in the distillation of coal, cannel, bituminous shale, boghead minerals, oils, petroleum, or other combustible substances, to the action of nitric acid, or of a mixture of nitric and sulphuric acids, by which nitro-benzole, and other compounds, are obtained, and certain substances removed from the gas employed. For this purpose, there is introduced into a series of earthenware vessels, arranged in the form of Woulfe's bottles, a quantity of fuming nitric acid, or a mixture of nitric and sulphuric acids, and through this is pressed a current of gas produced from any of the substances named, continuing the operation so long as any action is exerted by the acids upon the gas. When the operation is completed, the nitro-benzole is removed, and other products separating themselves from the acid liquid; this may be employed for purposes where weak nitric acid, or a mixture of it and oxalic acids, are required. This process may be used for the formation of the products of the action of the gases upon the acids, alone; but where the purification of the gases is desired for the purposes of illumination, it is preferred to use fuming nitric acid alone, which removes from the gases certain constituents that render them more liable to give off smoke in their combustion, whereby the odour of the gas is improved. In the process, a quantity of acid vapour is mechanically carried forward with the gas, and this may be brought into contact with alkalies, or mineral salts, capable of removing it from the gases. Where a mixture of nitric acid, and of rectified sulphuric acid is employed, it is preferred to use one part of nitric to two parts of sulphuric acid, and when fuming nitric acid is used, the strongest is preferred.

Illuminating Power of the Gas Supplied by the Paris Gas Company.—The Paris Gas Company is bound, according to its contract, to supply a gas with the illuminating power such that the consumption of 0·88 or the maximum specified 0·98 of a cubic foot under a pressure of one-tenth of water, should give as much light as 154 grains of purified colza oil burnt during the same time in a carcel lamp regulated to consume 648 grains of oil per hour. From the 1st of April to the 30th of June of the present year the result of the daily tests gave an average consumption of 0·85 of a cubic foot of gas to 154 grains of oil; the company thus supplied during that period a gas whose illuminating power was above the maximum required by the contract.

DOCKS, HARBOURS, BRIDGES, &c.

Large Swing-Bridge for Railway and Ordinary Traffic at Hull.—Messrs. Grissell, of the Regent's Canal Ironworks, have obtained the contract for, and just commenced the erection of, an immense swing-bridge, of peculiar design and massive proportions, at Kingston-upon-Hull. The bridge is intended to span the river Hull at points very near to the citadel and garrison of the town, and the extensive shipbuilding and engineering establishment of Messrs. Samuelson. It is to consist of one principal opening of 100ft. and a smaller one of 38ft. The superstructure of the principal opening will be carried back landwards, and is to be made to swing or open by aid of powerful mechanism. It will be supported by an abutment on the eastern bank of the river, and, when closed, by two cast-iron cylinders, also sunk into its bed. The superstructure of the smaller opening, which will not be moveable, will also be supported by the same cylinders and a western abutment. Both abutments will rest on foundations of pilework and concrete, and will consist principally of brickwork, with stone copings. The hollow in the eastern abutment will be filled in with concrete, as will the cylinders themselves. The traffic portion, or upper face of the bridge, will comprise an ordinary roadway, a tramway, and two footpaths, and the total width over all will be 40ft. The roadway, tramway, and footpaths will be carried over the principal opening by two main wrought-iron girders, which will be continued back landwards. The roadway, tramway, and footpaths are to be carried over the side opening by two smaller main wrought-iron girders. The roadway and tramway platforms will pass in between the main girders, and be supported on wrought-iron cross girders. These latter will project on either side beyond the main girders, for the purpose of carrying the footpath platforms. Railway and roadway trams will be laid on the bridge, and fencings, or parapets, of wrought-iron will protect the outsides of the footpaths. For the purposes of opening and shutting, the two larger main girders will be bolted to an upper roller frame, turning round a central pivot, and which rests again on rollers working in a live ring on the ends of radial bars. The radial bars themselves will be connected to and will work round the central pivot, fixed on a lower roller frame, upon and around which the rollers run. This lower frame will be bolted to stone blocks resting on the eastern abutments. Dwarf walling is to be erected around and within the space occupied by the bridge when opened for the navigation of the river, and the space is to be also pitched. Fender pilework and dolphins will be constructed so as to protect the eastern abutment, the cylinders, and the bridge itself from injury by shipping, or craft of a lesser kind. The gun metal bearings, in which the massive rollers of solid wrought-iron will turn, is to be composed of a hard mixture accruing from the following materials:—Copper, 84 parts; tin, 13 parts; and zinc, 3 parts. The construction will be known as the Hull South Bridge. It is to be completed within eighteen months from its commencement. The Hull South Bridge Company are the promoters of the work, but as the garrison will derive considerable advantage from its existence, the Government bears a share of its cost.

New Bridge in Derry.—This new bridge has been opened by the Lord Lieutenant of Ireland. The site is about 250 yards south-west of that occupied by the wooden one. The new bridge is 1172ft. in length, 30ft. wide, and consists of six principal openings—119ft. each—a double swing bridge, spanning two openings of 45½ft. each, and two subordinate openings, 62ft. each, landwards—one on each side of the river. The piers for the principal openings are each composed of two cylinders, 11ft. in diameter, and 24ft. apart, from centre to centre. The pier for the swing-bridge is composed of seven cylinders, each 8ft. in diameter, sunk into the bed of the river, and all enclosed in one large cylinder, 30ft. in diameter. The cylinders are all filled in with concrete. The principal openings are spanned by large girders, placed transversely, 24ft. apart, resting on granite blocks imbedded in the concrete contained in the cylinders. The bridge is a double one, the lower level being constructed for the transit of railway carriages, to be drawn across by horses, and the upper one being designed for ordinary traffic. The upper roadway is 20ft. wide, divided down the centre into two channels by the water tables; on either side of the carriage-road is a pathway 5ft. wide. The height of the railroad part over low water mark is 14ft., and the depth of water at high-tide under the swing-bridge is 33ft. The bridge is of iron.

MINES, METALLURGY, &c.

On the Separation of Lead and Antimony; (Read at Newcastle, at the British Association Meeting, by Dr. T. Richardson).—In the metallurgical treatment of lead ores, a certain proportion of the lead remains mixed with the impurities of the ore, in the form of slags. When these slags are smelted in the ordinary hearth, a hard lead is obtained, the hardness of which is generally due to the presence of antimony. Previous to 1840, these slag leads were with difficulty sold by the smelters at a lower price than soft lead, but in that year I introduced at Blaydon the process of softening or calcining these leads, by which plan 95 per cent. and upwards of good soft lead was obtained, and the dross produced was afterwards reduced, yielding a very hard lead. The calcining process consists in exposing the hard lead, in a melted state, to a current of hot air, when the antimony, with a certain quantity of lead, becomes oxidised, and this dross floats on the surface of the melted lead, whence it is skimmed off from time to time. The soft lead is then run off and ladled into moulds. The dross is reduced in the ordinary manner; but I have found that, by mixing a small quantity of alkali with the dross, the heat may be reduced and a better produce is obtained. The hard lead obtained from this reducing process can be treated in the same way as the original slag lead, but a much longer time is required to effect the removal of the antimony, and the produce of soft lead falls as low as 50 to 60 per cent. The following analyses illustrate the changes which take place in the hard lead by these operations:—

English Hard Leads.

	Original Lead.	1st Calcination.	2nd Calcination.
Lead	99·27	86·53	52·84
Antimony	0·57	11·29	47·16
Copper	0·12	traces.	traces.
Iron	0·04	0·34	traces.
	100·00	98·16	100·00

Soon after the commencement of the calcining operation at Blaydon, a quantity of hard lead was imported from Spain, and the late Mr. Burnett, by my advice, submitted it to this softening process, but he found that the usual brick furnace could not be made to retain the lead after it was melted. He then employed a cast iron pan, built into the brick furnace, and this simple arrangement was perfectly successful. The foundation was thus laid for the extraordinary trade in Spanish hard leads which is carried on to so great an extent in Spain, France, and England. The Spanish hard lead, when submitted to a similar treatment to that already described, furnishes the following analytical results:—

Spanish Hard Lead.

	Original Lead.	1st Calcination.	2nd Calcination.
Lead	95·81	64·98	56·60
Antimony	3·66	29·84	43·40
Copper	0·32	5·90	traces.
Iron	0·21	0·20	traces.
	100·00	100·92	100·00

I have already mentioned the beneficial action which a small quantity of alkali exercises in the reduction of the hard dross, which is strikingly shown in the following analyses of two samples of lead, reduced from the same parcel of dross, with and without the addition of the soda:—

	With 2½ per cent. of alkali.	Without alkali.
Lead	58·70	82·88
Antimony	40·66	16·09
Copper	0·32	0·68
Iron	0·32	0·35
	100·00	100·00

In these operations a quantity of refuse products accumulate in the smelting works, which are sometimes reduced, especially in Spain, in a small blast furnace. After some time, the hearth of these furnaces is filled with a spongy, semi-fused mass, called a *cuesco* by the Spaniards, one of which was found to contain:—

Lead	61·35
Antimony	29·50
Copper	8·30
Iron	·61
Nickel	traces.
	99·76

The antimony-lead obtained from the second calcination answers very well for the casting of type furniture, and also for the coarser kind of type.

Copper Mining in Italy.—An interesting account of the operations at the Monte Catini Copper Mine, Tuscany—the most successful in Italy, and perhaps one of the most profitable in Europe, has been contributed by Mr. Nelson Boyd, Mining Engineer:—"The existence of copper in this district appears to have been known in remote antiquity. From old workings discovered, it is proved that the Etruscans were aware of the value of these hills, and worked them for copper. It is also found from records that Monte Catini was also worked in the middle ages; but that the works were stopped by the terrible plague which raged in 1300, and which changed the fertile and populous Marrema into a wilderness; from which condition it has only been recently attempted to be rescued by drainage and cultivation. In the year 1820, some unsuccessful trials were made on the site of the present mine; and again, in 1830, a shaft was sunk—the lode discovered—and several levels (among them a deep adit) driven, but only an insignificant quantity of ore raised. It was not till the year 1837, shortly after the mine came into the hands of the present proprietors, Messrs. Hall and Sloane, that the workings showed any importance. In that year a large mass of ore was discovered, from which sufficient was raised to pay all working expenses for a year—which appeared to establish beyond all doubt the success of the undertaking, a view fully realised by subsequent events."

Pig Iron.—The computed make of pig iron in England and Wales last year was 2,863,469 tons against 2,763,390 tons in 1861, 2,888,752 tons in 1860, and 2,273,243 tons in 1854. The make in Scotland last year was computed at 1,080,000 tons against 1,040,000 tons in 1861, 1,000,000 in 1860, and 775,000 tons in 1854. The total number for the United Kingdom consequently advanced from 3,048,243 tons in 1854 to 3,943,469 tons in 1862. The number of furnaces in blast last year was 556 against 568 in 1861, 589 in 1860, and 554 in 1854. The average price last year was 35s. per ton against 49s. 3d. per ton in 1861, 53s. 6d. per ton in 1860, and 79s. per ton in 1854. Of the 556 furnaces in blast last year, 436 were in England and Wales, and 120 in Scotland.

Colliery Ventilation.—A successful trial of a machine for this purpose has been made at Bonville's Court Colliery, near Tenby. The machine is a large circular fan, improved and constructed by Mr. Waddle, of the Launmore Works, Llanelly, of 18ft. diameter, by 4ft. breast, and is so arranged on the surface over the upcast shaft that it absorbs all the foul air and gas from the colliery without any leakage, and thus, probably, may supersede the large furnace at the bottom of the shaft, which is so often placed in such dangerous proximity to these large reservoirs underground. This fan-wheel is driven by a steam engine of 18 inches cylinder and 20 inches stroke, producing an average of 120 revolutions per minute in the fan.

APPLIED CHEMISTRY.

On the various Kinds of Pyrites used on the Tyne and Neighbourhood in the Manufacture of Sulphuric Acid; (Read at the Meeting of the British Association, Newcastle, by J. Pattinson, Analytical Chemist).—Iron pyrites or bisulphide of iron has been used on the Tyne in the manufacture of sulphuric acid since about the year 1840. At that time, and up to 1856, the only supplies of this mineral were obtained from Ireland, Cornwall, and the collieries of this district, where it occurs and is associated with coal, and is known by the name of coal brasses. But since 1856 other and more abundant supplies have been obtained from Spain, Portugal, Belgium, Westphalia, Norway, Sweden, and Tuscany. At present the total consumption of pyrites on the Tyne and neighbourhood is about 70,000 tons per annum, representing a value of about £105,000. The following table represents the composition of the principal kinds of pyrites at present used. The samples analysed are chiefly fair average samples of cargoes brought to the Tyne:—

	1.	2.	3.	4.	5.	6.	7.
Sulphur	44·60	49·30	45·01	45·60	46·50	44·20	38·10
Iron	38·70	41·41	39·68	38·22	39·22	40·52	34·44
Copper	3·80	5·81	...	...	1·80	0·90	trace
Lead	0·58	0·66	0·37	0·64	...	1·50	...
Zinc	0·30	trace	1·80	6·01	1·18	3·51	...
Thallium	trace	trace	trace	trace	...	...	...
Lime	0·14	0·14	0·25	0·11	2·10	0·24	4·96
Magnesia	trace	trace	...	...	0·01	...	0·33
Carb. acid	...	...	...	...	1·65	...	5·11
Arsenic	0·26	0·31	trace	trace	...	0·33	trace
Oxygen	0·23	0·25	0·42	0·37	0·45	0·25	0·31
Coal and loss	...	...	...	...	...	...	14·45
Gangue	11·10	2·00	12·23	8·70	9·08	8·90	1·40
Moisture	0·17	0·05	0·25	0·38	0·17	0·90	0·90
	99·88	99·93	99·91	100·30	100·16	100·34	100·3

No. 1. Spanish pyrites, obtained from the districts of Huelva in Spain and Algarvo in Portugal. About 30,000 tons per annum used on the Tyne. No. 2. Ditto. No. 3. One of the Belgian varieties, obtained from the Rochenx mine, Theux, near Spa. About 12,000 tons of Belgian pyrites used on the Tyne per annum. No. 4. Westphalian pyrites. Consumption on the Tyne about 6000 tons per annum. This is one of the most abundant sources of the newly-discovered metal thallium. No. 5. Norwegian pyrites, obtained from the Island of Hitteren, in the Bay of Drontheim. About 6000 tons per annum used on the Tyne. No. 6. A rich variety of Irish pyrites, obtained from the Wicklow mines. About 4000 tons of Irish pyrites used on the Tyne per annum. No. 7. Coal brasses, sample obtained from the Walker Colliery. About 7000 tons per annum used on the Tyne for the manufacture of sulphuric acid. Other analyses of pyrites are also given in the paper. The methods of burning, the treatment of the residuum, and various objectionable varieties of pyrites are also described.

Results of an Examination of the Process for Manufacturing Prussiate of Potash, by the late Mr. John Lee and Dr. Richardson.—These experiments were made as far back as 1847, but the notes had been overlooked, and were only found when it became necessary to prepare an account of the manufacture of this salt for the new edition of the Chemical Technology. The experiments were made in gun-barrels, and the same mixture of materials was employed in each case. Clean horn, carefully rasped, was mixed with the best potashes and iron filings. A small quantity of water was added, to assist in making an intimate mixture, which was carefully dried and reduced to a fine powder. This mixture was composed of—

Horn	16·00
Potashes	17·72
Iron	3·00
Moisture	3·28
	40·00

A potash-charcoal was made by soaking 13 parts of wood-charcoal with a solution of four parts of potashes, and then perfectly dried. A gun-barrel was partially filled with the mixture, and exposed to a red heat in a separate furnace. In the first and second series of experiments, the gases generated in the gun-barrel were passed through the potash-charcoal, which was maintained at a red heat in an iron tube placed in another furnace. In the third series of experiments, the gases were passed through hydrochloric acid, and in the last experiments the gases escaping from the iron tube containing the potash-charcoal were conveyed through hydrochloric acid and then through a solution of potash. In the last series, the gases which escaped were collected and analysed. In each case the prussiate was extracted and crystallised. The ammonia was determined in the usual way, but in the tabulated results which follow the ammonia is given in its equivalent of crystallised prussiate of potash. The theoretical yield of prussiate was 382·50, and the actual quantities obtained were as follows:—

	1.	2.	3.	4.
Retort	101·97	135·46	146·93	141·08
Tube	68·25	63·54	...	71·00
Acid	...	...	140·24	58·80
Potash	...	...	...	2·75
Total	170·22	199·00	287·17	273·63
Loss	212·28	183·50	95·33	108·87
Produce per cent.	44·5	52·2	75·1	71·5

The gases were not collected until the air had been expelled from the apparatus, and consisted of—

Hydrogen	46·00
Carburetted hydrogen	14·66
Carbonic oxide	25·34
Nitrogen	14·00
	100·00

It would therefore appear that part of the nitrogen of the animal matters is eliminated in its ultimate form, and cannot be made available in this manufacture. It would also appear that a modification of the apparatus used by manufacturers would probably be followed by a much larger produce than is at present obtained.

Detection of Nitric Acid in Potable Water by means of Brucine; (read at the British Association Meeting, Newcastle, by R. Kersting).—The author makes a solution of one part of brucine in 1000 parts of water. He pours a cubic centimetre of this solution into a glass, and adds a cubic centimetre of the water under examination for nitric acid; he then pours very slowly down the side of the glass a cubic centimetre of sulphuric acid, so that the acid may form a layer at the bottom of the glass. Then, if nitrates are present in water, a zone of rose-colour appears on the surface of the acid. The zone turns yellow on its lower surface, but remains without further change for some hours. By carefully shaking the glass the rose colour may be made to reappear above the yellow zone. A cubic centimetre of water containing 1 ten-thousandth of nitric acid shows the reaction very decidedly, but it may be seen when the amount of acid is ten times less. As the sulphuric acid, the brucine, and water employed to dissolve it may contain nitric acid, this source of fallacy must be guarded against, and the author recommends that the water should be distilled from potash, the sulphuric acid distilled with about 5 per cent. of carbonate of ammonia, collecting only three-fourths of the acid, and the brucine well washed with distilled water.

Preservative Properties of Coal Tar.—M. Rottier has placed a paper before the Royal Academy of Belgium, upon the preservation of wood by the heavy oil of coal-tar, in which he states that, after reviewing the number of compounds this complex product contains, the volatile hydrocarbons, aniline, phenic acid, and naphthaline, do not possess any preservative properties; but that a green oil, which is produced in the distillation of coal-tar at a temperature of about 572 deg. Fahrenheit, is the substance alone that resists the decay of wood.

On the Presence of Sulphur in Materials used for Lighting Purposes, and the Mode of Detecting the Same; by M. H. Vohl.—Endeavours have always been made to separate from gas for lighting purposes the sulphur which it generally contains, so as to prevent in its combustion the formation of sulphurous acid. This acid not only exercises a deleterious influence upon the respiratory organs, but also destroys the vegetable colours of tapestry, paper-hangings, &c. It is generally considered that the sulphur found in coal gas is in the state of sulphuretted hydrogen or sulphuret of carbon, and metallic oxides are used for the absorption of these impurities. M. Vohl has made experiments upon different samples of commercial benzine, and from the result he concludes that benzine often contains sulphur in combination, which is found in that portion that boils under 176° Fahr. The sulphur in combination with the carburetted hydrogen cannot be separated without destroying them. On passing gas obtained from the distillation of coal through metallic pipes, kept cool, we obtain, beside water, a mixture of naphthaline and benzine, an oil of an unpleasant odour, boiling below 176° Fahr., and containing the hydrocarbonated combination of sulphur. The apparatus employed by M. Vohl is composed of a tin worm about 11 yards long and half-an-inch internal diameter, surrounded by a mixture of ice and salt. The benzine water and naphthaline form in the interior of the worm oily concretions, whilst the sulphuretted hydro-carburet falls into a glass receiver at the bottom of the worm, also surrounded by a freezing mixture. The gas submitted to trial was free from sulphuret carbon, and the sulphuretted hydrogen removed by its having been washed in basic acetate of lead. To discover the sulphur in benzine and in the oil obtained from coal gas, M. Vohl employs the following method:—Introduce 30 to 45 grains of the oil, supposed to contain sulphur, into a dry test tube, to which add a piece of potassium, the surface being freshly cut; this mixture is then submitted for 10 to 15 minutes to the temperature of boiling oil. If the suspected oil contain sulphur, the brilliant surfaces of the potassium become covered with a red or brown pellicle, composed of sulphuret of potassium. On then adding a few drops of distilled water, it becomes partly decomposed by the potassium, and dissolves the sulphur set free; one drop of alkaline nitroprussiate, if now added to this liquor, is sufficient to obtain the beautiful violet colour characteristic of sulphur. The purified commercial benzine almost always contains a certain quantity of sulphur, which may be detected by the above means. Sodium may be employed as effectively as potassium. It often occurs that oils originally exempt from sulphur, contain it after having been treated by sulphuric acid. As, for example, the oily products arising from the distillation of bituminous schists are composed of a mixture of aldehydes and acetones, which both easily combine with alkaline sulphites. When oils contain the sulphur in the state of sulphurous acid, the potassium test can also be employed; the sulphurous acid is decomposed, and an alkaline sulphuret is formed. The brown appearance upon the surfaces of potassium preserved in naphtha arises very often from the sulphur contained in the oil

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent, Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated September 25th, 1863.

2362 C. de Wailly—Improved slipper or clog, principally intended for bath rooms.
2363 A. V. Newton—Joint for the tube of surface condensers.
2364 P. Spence—Production of sulpho-cyanide of ammonium and other sulpho-cyanides.
2365 E. Lloyd—Improvements in rotary engines to be worked by water, steam, air, and other motive power.
2366 M. Schaffhauser—Making paper tubes used in spinning manufactories.

Dated September 26th, 1863.

2367 G. Spill, T. J. Briggs, & D. Spill—Manufacture of driving straps or bands and of flexible tubes or hose.
2368 W. T. Rowlett—Improvements in crinolines and hooped skirts.
2369 R. Clarke—New application of material for covering crinolines, and the manufacture of the said material.
2370 W. Clark—Improved fabric for the production of permanent electricity.
2371 J. Spence—Improved plastic composition applicable to the coating of metallic and other surfaces.
2372 A. Gleerup—Improved construction of gas burner.
2373 L. H. Norris—Manufacture of india rubber and gutta percha compounds.
2374 W. Malan & W. Tic—Apparatus for supplying gas to railway carriages and other moving structures.
2375 E. B. Wilson—Steam boilers and other furnaces and fireplaces.

Dated September 28th, 1863.

2376 T. Lowe—Self-acting lock, lever, band, railway engine, tender, carriage, waggon, or conveyance car break.
2377 L. J. J. Jean—Construction of steam boilers and their fire grates.
2378 P. Bouchaud—Improved wax-light or candle stand.
2379 P. Cato—Construction of combined iron and timber ships.
2380 J. T. & E. Harlow—Improvements in breech-loading fire-arms.
2381 W. E. Gedge—Apparatus for heating by means of illuminating gas
2382 J. H. Johnson—Manufacture of boot and shoe toe pieces or tips.
2383 J. Bailey, G. W. Blake, & W. H. Bailey—Regulating and indicating the flow and pressure of liquids and fluids.
2384 G. Thomas—Louvre shutters and Venetian blinds.

Dated September 29th, 1863.

2385 F. Preston—Rolling and cutting files and rasps.
2386 F. G. Mulholland—Manufacturing submarine telegraph cables.
2387 S. Mendel—Manufacture of woven fabrics, applicable to covering telegraph wires.
2388 H. Haigh & R. Heaton—Dyeing cotton or other vegetable fibrous substances.
2389 W. Clark—Improvements in the soles of boots and shoes.
2390 W. E. Gedge—Parts of the permanent way of railways.
2391 J. Cooper—Improvements in the construction of harrows.
2392 P. & J. Llewellin & J. W. James—Water closets.

Dated September 30th, 1863.

2393 J. J. Cbidley—Improved bottle and stopper.
2394 W. Clarke—Improvements in musical instruments.
2395 H. E. Skinner—Conical packing for taps.
2396 E. S. Attree—Cigar holder.
2397 E. W. Bullard—Machine for turning and spreading hay.
2398 G. Elliot—Props and supports for coal and other mines.
2399 B. Browne—Sight-piece for rifles.

Dated October 1st, 1863.

2400 W. Smith—Improved process for re-crystallising sugar.
2401 J. Mackay—Improvements in fire-arms, ordnance, and projectiles.
2402 T. Bell—Bricks and tiles.
2403 H. A. Bonneville—Improvements in railway and other breaks.
2404 L. N. le Gras—Improvements in cooking stoves and apparatus.
2405 F. Reid—Collecting and saving the spirit of alcohol generated by spontaneous fermentation in raw sugar, concrete, melado, and molasses, and thrown off during the process of boiling or refining.
2406 J. Bell—Improvements in couplings for railway carriages.
2407 W. E. Newton—Apparatus for cleaning rice and other grain.
2408 G. Dickey—Winkers or eye-screening apparatus for horses and other animals.
2409 P. Leslie—Preserving the bottoms of ships or vessels and other surfaces from the prejudicial effects of marine animals and vegetables.
2410 T. Horsley—Improvements in breech-loading fire-arms.
2411 J. J. Anderton—Manufacture of boots and shoes.

Dated October 2nd, 1863.

2412 J. Farrar—Spinning and doubling wool, alpaca, mohair, cotton, silk, flax, and other fibrous substances.
2413 J. E. F. Ludeke—Improvements in obtaining motive power.
2414 R. Charlton—Improvements in metallic bedsteads.
2415 J. Tees—Improvements in packing for stuffing boxes and pistons.
2416 J. G. Tongue—Compound reactive agent and universal mordant to be employed in the processes of dyeing and printing.
2417 W. E. Gedge—Improved pen holder and feeder.
2418 J. J. Lundy & R. Irvine—Manufacture of paper.
2419 W. A. Torrey—Lubricating the axles of railway carriages.
2420 G. T. Bousfield—Improvements in revolver fire-arms.
2421 G. & W. T. Shepherd—Storing the crystals of lump or refined sugar.
2422 J. Bowron & G. Robinson—Improvements in the manufacture of soda.

Dated October 3rd, 1863.

2423 J. Schofield, J. Kirk, & W. Spivey—Looms for weaving.
2424 G. R. Tilling & J. Park—Filling tobacco pipes of an improved construction.
2425 E. B. Wilson—Manufacture of iron and other metals
2426 T. & J. Fagg—Manufacture of boots and shoes.
2427 E. Pratt—Finishing woollen fabrics made on twist lace machinery.
2428 I. Bonomi—Construction of arches and other like structures.

Dated October 4th, 1863.

2429 W. Hoehl, C. Brakell, & W. Gunther—Improvements in rotary engines worked by steam, water, or other motive power.
2430 C. Brakell, W. Hoehl, & W. Gunther—Motive engines worked by water, steam, or other motive power.
2431 J. M. & J. Stanley—Improvements in propelling.
2432 C. Tomlinson—Improvements in taps, cocks, hydrants, or valves.
2433 J. W. Guilmette—Substitute for whiting, pipe clay, and other analogous substances to be employed to produce a white coating or surface.
2434 W. H. Bailey—Combing wool and other fibrous substances.
2435 G. H. Ellis—Apparatus for aiding the combustion of fuel.
2436 B. G. George—Tablets, show bills, and trade announcements.
2437 T. Ivory—Steam engines and furnaces and boilers for the same.
2438 J. Towlson—Improvements in apparatus for cooling liquids.
2439 R. Pepper—Machine for pressing or crushing spent bops.
2440 W. Legg—Improvements applicable to sewing machines.

Dated October 6th, 1863.

2441 S. Mathews—Improvements in breech-loading fire-arms.
2442 E. Whitehouse—Manufacture of wrought iron shackles.
2443 W., H., & T. Holgate—Improvements in the manufacture of pickers
2444 R. A. Brooman—Improvements in steam boilers and furnaces.
2445 W. Batchelour—Moulding and modelling palates, teeth, and gums for dental purposes.
2446 G. Dyer—Improvements in the construction of railway carriages.
2447 A. Johnston—Improvements on railway carriages.

Dated October 7th, 1863.

2448 E. Jones—Pumping.
2449 D. Banu—Regulating and working window blinds.
2450 E. Leak—Apparatus to be used in placing glost china and earthenware in ovens and kilns for firing, burning, or baking such ware.
2451 J. Caddick—Runners, runner notches, and top notches for umbrellas, and parasols.
2452 G. F. Graham—Improvements in high pressure cocks.
2453 C. P. Button—Lamps especially applicable to the burning of hydro-carbons.
2454 C. P. Button—Pumps.
2455 C. P. Button—Harrows.
2456 R. Zox—Improvements in the manufacture of academic caps.
2457 A. Rigg, jun.—Improvements in propelling vessels
2458 E. Slaughter—Improvements in locomotive engines
2459 J. Gibson—Improvements in cast iron pit tubing.
2460 G. Wbight—Washing apparatus.
2461 J. H. Johnson—Improvements in the permanent way of railways.

Dated October 8th, 1863.

2462 J. H. Johnson—Propelling ships.
2463 A. P. Charpentier—Improvements in the manufacture of watches.
2464 C. Crosswell—Improvements in breech-loading fire-arms.
2465 M. Smith—Washing, cleansing, salting, and packing butter.
2466 G. Canouil & F. A. Blanchon—Shooting toy fusees, toy rockets, or other similar toy missiles, by means of toy pistols or other toy fire-arms.
2467 W. Lorherz—Improvements in the manufacture of gas from tar.
2468 J. D. Dougall—Camel guns and other light artillery.
2469 R. G. Watson & W. J. Kendall—Walking stick umbrells.
2470 J. Mead—Construction of various articles of furniture.
2471 J. Spencer—Machinery for separating different sizes of roots.
2472 A. V. Newton—Improvements in the construction of condensers.

Dated October 9th, 1863.

2473 L. Lefebvre—Improvements in vapour bath apparatus.
2474 J. Wood, J. Whitehead, & T. Tetlow—Governing the speed of steam engines.
2475 J. Elsom—Parallel turning.
2476 E. W. James—Raising sinking or submerged ships.
2477 G. Parry—Improvements in refining crude pig iron.
2478 J. M'Innes—Sheathing for navigable vessels of iron or wood.
2479 J. Mather—Improvements in friction or glazing calenders.
2480 D. Lange—Railway wrappers.
2481 N. Fellows—Extinguishing fires in chimneys and flues, regulating and promoting draught therein, and to act as a ventilator.
2482 R. Martyn—Condensing and purifying the fumes and gases arising from the treatment of metals and metallic ores and substances.
2483 R. A. Brooman—Amalgamating and separating gold and silver from quartz and earth containing the same.

Dated October 10th, 1863.

2484 G. W. Reynolds—Manufacture of bands or strips for crinolines.
2485 J. Vaughan—Purifying waste gases from blast and other furnaces.
2486 S. Banner—Storing petroleum and other like oils and spirits.
2487 J. Ruthardt & F. Thiele—Purifying and increasing the illuminating power of gas.
2488 W. B. Fairbanks & J. & F. Lavender—Manufacture of hames.
2489 D. Proudfoot—Printing or dyeing textile fabrics.
2490 J. W. Goundry—Improvements in musical instruments.
2491 T. Hughes—Lanthorns.

Dated October 12th, 1863.

2492 A. Inglis—Taps or cocks.
2493 P. R. Jackson—Hoops and tyres for railway wheels.
2494 W. Hutchinson—Manufacture of fittings for powder flasks.
2495 J. G. Hartley—Iron and wooden ships and other vessels
2496 J. Heap—Perforating machines.
2497 W. T. Bury—Baths for containing heated metals and fluxes employed in the processes of hardening and tempering steel.
2498 T. Browning—Metallic casks.
2499 T. Gidlow—Bearings for axles for railway or other carriages.
2500 T. Fox—Cleaning out the tubes of steam boilers.
2501 W. E. Gedge—Shears for cutting metals and other substances.
2502 C. Humfrey—Purifying hydrocarbons.
2503 R. Aitken—Improvements in the permanent way of railways.
2504 G. Mouuttord—Cotton gin.
2505 J. J. Anderton—Cutting and finishing the edges of the soles and heels and the bottoms of boots and shoes.

Dated October 13th, 1863.

2506 J. Dodge—Rolling, shaping, or forging metals.
2507 G. Morgan—Bag for postal and other purposes.
2508 J. E. Poynter—Throwing projectiles by means of explosive agents
2509 J. Place—Finishing paper
2510 A. Rolfe—Propelling carriages on railways, tramways or on common roads.
2511 T. C. Craven—Cotton gins.
2512 T. Scott—Floating docks.
2513 J. Fowler—Apparatus used for hauling agricultural implements
2514 A. Crellin—Omnibus indicator.

Dated October 14th, 1863.

2515 J. Rowley—Washing, scrubbing, scouring, bleaching, and discharging impurities or other matters from woven or other fibrous materials.
2516 J. Luchley—Valves for double cylinder steam engines.
2517 E. P. Colquhoun & J. P. Ferris—Fire bars for the furnaces of steam boilers.
2518 M. F. D. Cavalerie—Obtaining centrifugal motive power.
2519 J. Milton—Looms.
2520 W. J. Rideout—Boiling rags.
2521 O. E. Sonnenstein—Reflecting apparatus.
2522 H. A. Bonneville—Cleaning ships' hulls.
2523 R. H. Smithett—Application of wheels to railway carriages.

Dated October 15th, 1863.

2524 R. Bewley, jun.—Wrenches.
2525 P. Lesley—Rails for railways.
2526 H. Clayton—Buildings for drying bricks, tiles, and other articles.
2527 S. R. Smith—Connecting chain cables, clearing a ship's hawse when foul, and presenting strain to the chain cables when ships are riding at anchor.
2528 H. W. Hart—Suspending T fastenings.
2529 B. F. Weatherdon—Removing dirt from boots or shoes.
2530 S. Flexen—Ventilating apparatus.

Dated October 16th, 1863.

2531 J. Polglase & J. Cox—Cleaving stone.
2532 E. Rowing—Steam engines and boilers.
2533 R. A. Brooman—Pumps.
2534 F. A. E. G. de Massas—Smut machines.
2535 F. G. Stuber—Application of blast heat.
2536 S. Jay—Stockings and drawers.

Dated October 17th, 1863.

2537 M. Meisel—Weighing apparatus.
2538 S. Berrisford & W. Ainsworth—Looms.
2539 J. Shanks—Valves or taps.
2540 W. Hampson—Looms.
2541 W. Routledge & F. F. Ommaney—Baling boxes.
2542 W. Clark—Rotary engines.
2543 Y. Meirat—Propelling vessels.
2544 W. Clark—Sewing and embroidering machines.
2545 L. R. Chesbrough—Let-off motion for looms.
2546 J. H. Johnson—Washing machines.
2547 W. Darlow & R. H. Lawson—Obtaining motive power.
2548 J. Wright—Cutting railway sleepers.
2549 E. H. C. Mouckton—Joining sheets of metal.
2550 F. de Wylde—Induration of stone, cement, stucco, brick, and other materials.
2551 F. de Wylde—Separation of molasses and other impurities from sugar crystals.

Dated October 19th, 1863.

2552 J. Champion—Preparing, spinning, and doubling fibrous materials.
2553 H. Gilbee—Rendering boots and shoes water-proof.
2554 W. Fletcher—Breech-loading fire-arms.
2555 A. Budenberg—Blasting powder.
2556 J. Whitley—Permanent way of railways.
2557 L. Evnard—Brakes.
2558 W. Clark—Separating ores from their gangues.

Dated October 20th, 1863.

2559 J. Taylor & J. & J. Lees—Opening, cleaning, and mixing fibrous materials.
2560 E. H. Luebbers—Substitute for cotton.
2561 W. Ingham—Copper rollers.
2562 C. T. Norley—Combustion of gas.
2564 J. Vaughan—Pecks, hoes, and other tools.
2563 D. Mills—Moulds for casting studs for chains.
2565 J. Michaelis—Purses and pocket-books.
2566 W. Snell—Condensers for steam engines.
2567 H. Hennessy—Projectiles.
2568 M. Petenkofer—Regenerating the surface of pictures.
2569 J. Bryant—Vent apparatus.
2570 H. B. Barlow—Boots and shoes.
2571 W. A. Dixon—Making aluminate of soda.
2572 G. Davies—Forming stitches over the edges of fabrics.
2573 J. W. Nottingham—Hansom cabs.
2574 G. H. Daglish & T. Windus—Bending plates for iron ships.
2575 C. Garton & T. Hill—Evaporating, cooling, and melting.
2576 W. N. Hutchinson—Ordnance.
2577 T. Restell—Walking stick umbrella.

Dated October 21st, 1863.

2578 W. Hartcliffe—Mules.
2579 T. C. Clarkson—Making and ornamenting various articles.
2580 J. Hinton—Breech-loading fire-arms.
2581 C. Schiele—Governors.
2582 N. F. Taylor—Increasing the power of gas.
2583 G. Howell—Condensing fumes.
2584 T. Hodson, W. Nightingale, & R. Laird—Carding cotton.
2585 G. Haseltine—Weighing machines.
2586 E. Alcan—Ornamenting cloths.
2587 R. A. Brooman—Treating ligneous substances.
2588 Z. Colburn—Steam engines.
2589 W. Cooke—Saponaceous compounds.
2590 J. Dodd—Mules.
2591 W. E. Newton—Sewing machines.

Dated October 22nd, 1863.

2592 G. Cutler, jun.—Boilers.
2593 R. Bailie—Floating docks.
2594 H. Wilson—Lubricator for steam engines.
2595 J. Craven & S. Fox—Punching, shearing, and burnishing
2596 A. A. Croll—Disinfectants.
2597 C. Tusnot—Cartridge bottoms.
2598 J. W. Friend & B. F. Weatherdon—Valve and valve gear for regulating the passage of fluids.
2599 F. Bullock—Ships logs.
2600 J. Mitchell—Excavating in the earth.
2601 C. Parker—Winding yarns or threads.
2602 J. Weems—Drying, cleaning, and cooling grain.
2603 A. Kinder & J. Inglis—Metallic foils.
2604 B. Noakes and F. J. Wood—Metallic casks, bottles, and other vessels.
2605 C. J. Pownall—Preparing and cleansing vegetable fibres.
2606 W. W. Pardon—Paper and pulp.
2607 R. A. Brooman—Tanning.
2608 H. Brunson and J. Alcock—Plaiting or folding fabrics.
2609 T. and A. L. Dickins and H. Heywood—Dyeing threads of silk.
2610 A. Turner—Looms.

Dated October 23rd, 1863.

2611 J. L. Jurgens—Vessels of war.
2612 B. Marriott—Cylindrical dead beat independent centre seconds watches.
2613 M. A. Boyle—Portable writing cases and despatch boxes.
2614 A. J. Martin—Improved lamp burner.
2615 J. Claes—Regulating the emission of gas.
2616 J. T. Webster—Driving the spindles of doubling and spinning frames.

LOCOMOTIVE ENGINEERING

GRAFFENSTADEN GOODS ENGINE.

FIG. 1

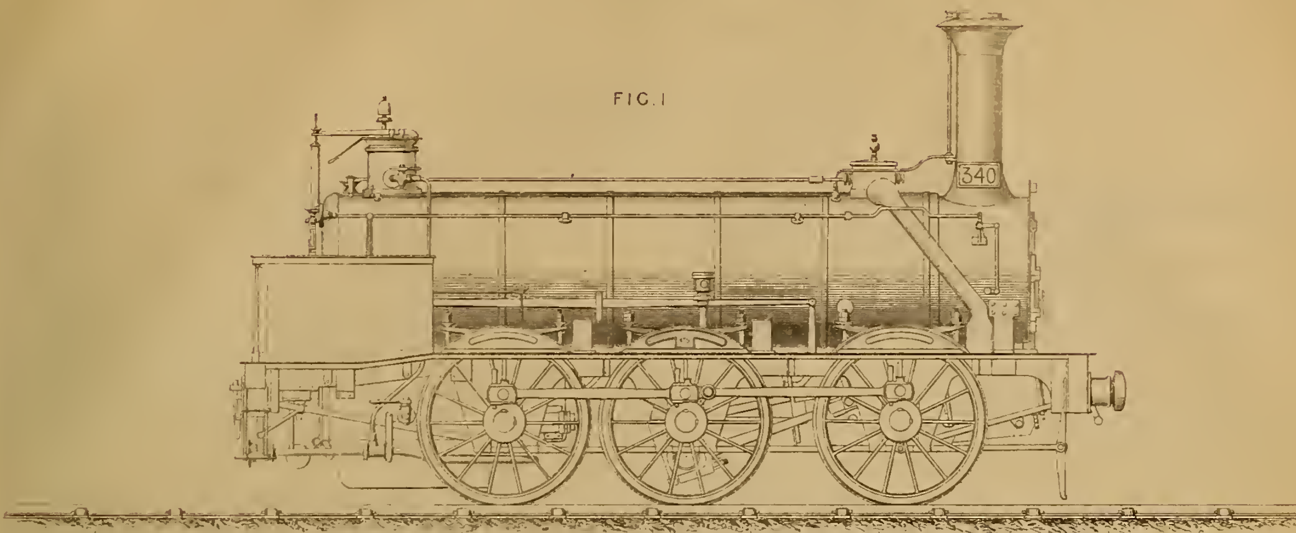


FIG. 2

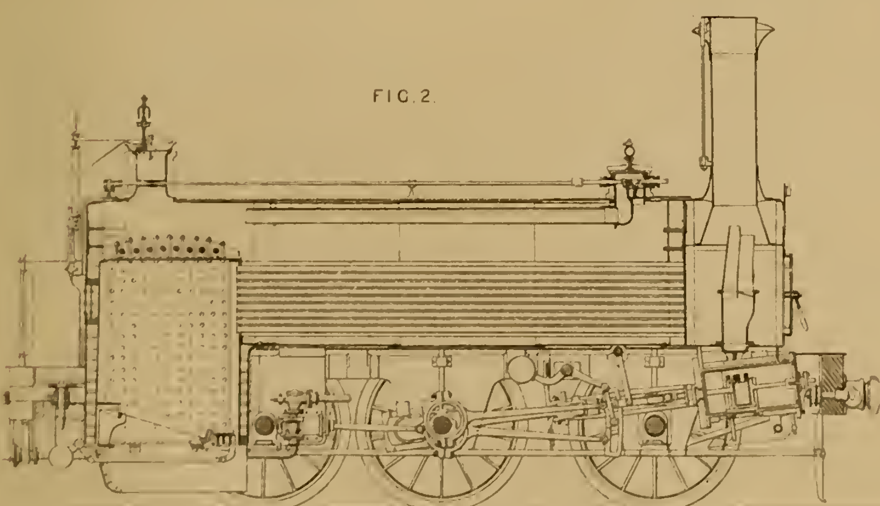


FIG. 3.

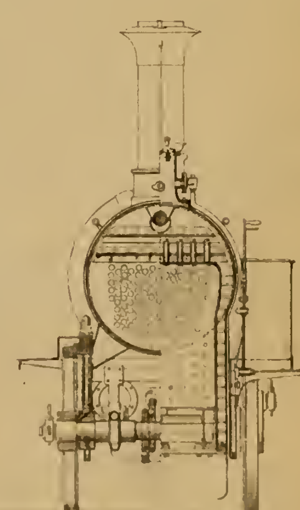


FIG. 4

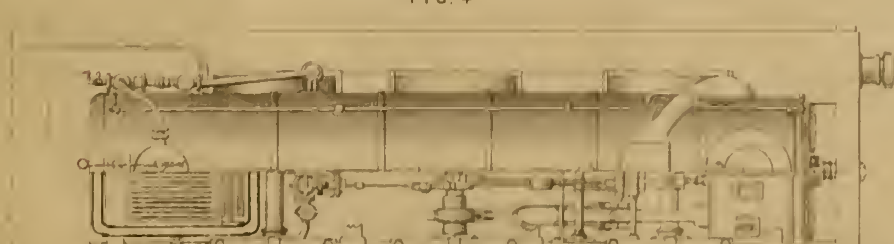


FIG. 5

THE ARTIZAN.

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DECEMBER 1st, 1863.

A CRITICAL AND HISTORICAL REVIEW OF LOCOMOTIVE ENGINEERING.

By J. J. Birckel.

(*Illustrated by Plates* 254, 255,* *and* 256.*—*Concluded from page* 241.)

Continuing our notice of the types of locomotives, figures 1, 2, 3, and 4, Plate 256, represent one of Mr. Sinclair's standard goods' engines, as in use upon the Great Eastern Railway. They work goods' trains, consisting of 35 waggons, weighing, loaded, 300 tons, at an average speed of 20 miles per hour, with a consumption of 36lbs. of coal per mile. They also work passenger trains, consisting of from 15 to 18 carriages, at an average speed of 25 miles per hour, with an average consumption of 25lbs. of coal per mile. Their dimensions and leading features are as follows :—

Boiler Barrel.—11ft. 5$\frac{3}{4}$in. long × 3ft.11in. diameter, made of $\frac{7}{16}$in. plates, single rivetted. Besides the dome which is placed on the crown of the barrel, there are two large hand holes placed underneath, provided with large blow-off cocks for facility of draining the boiler of the sediment from the water; height of centre from rails, 5ft. 10$\frac{1}{2}$in.

Fire-box Shell.—Flush at the crown with the barrel, 4ft.8in. long × 3ft. 10$\frac{1}{2}$in. wide, made of plates $\frac{7}{16}$in. thick; there are two 3$\frac{3}{4}$in. safety valves, placed one on top of the fire-box shell, and the other on top of the dome, each provided with a spring balance.

Fire-box.—4ft. $\frac{3}{4}$in. long × 3ft. 4$\frac{1}{2}$in. wide × 4ft. 8in. deep, made of $\frac{1}{2}$in. copper plates, except the tube plate which is $\frac{7}{8}$in. thick, provided with smoke-burning apparatus, described in our paper on the boiler.

Heating Surface.—192 brass tubes, 1$\frac{7}{8}$in. diameter × 11ft. 8$\frac{11}{16}$in. long = 968·5 square feet ; fire-box, = 72·3 square feet ; total, 1040·8 square feet.

Fire Grate.—4ft. $\frac{3}{4}$in. long × 3ft. 4$\frac{1}{2}$in. wide = 13·5 square feet. Fire bars and frame of the ordinary construction ; the bars, made in two lengths, are 20 in number in the width of the fire-box, with a space of $\frac{3}{8}$in. between them.

Smoke-box.—2ft. 7$\frac{1}{4}$in. long × 2ft. 4in. radius, made of $\frac{1}{4}$in. plates, enclosing the cylinders entirely ; and provided with a man-hole at the bottom for facility of clearing out the cinders.

Chimney.—15in. diameter at bottom, and 18in. at top ; made of $\frac{3}{16}$in. plate ; 13ft. high, measured from the rails.

Cylinders.—Outside, 17in. diameter × 24in. stroke, with back bottom cast solid with the body ; steam pipes, 4$\frac{1}{2}$in. diameter ; steam ports, 12in. long × 1$\frac{1}{2}$in. wide ; exhaust port, 3in. wide ; blast orifice, 4$\frac{1}{2}$in. diameter ; lap of valve, 1$\frac{1}{4}$in. ; lead, $\frac{1}{4}$in. ; piston rod and valve spindle made of Krupp's steel.

Link Motion.—Stationary link, as illustrated and described in detail, in our paper treating of the link motion (in The Artizan, of March, 1863). Link, 19in. long ; eccentrics, 5$\frac{1}{2}$in. throw.

Connecting Rod.—6ft. long, made of best fagotted iron, with short fork at cylinder end ; cross head pins, 2in. diameter × 2in. long ; crank pin bearing, 3$\frac{3}{4}$in. diameter × 3$\frac{1}{2}$in. long ; crank pins made of Krupp's steel.

Feeding Apparatus.—Two No. 8 Giffard's injectors, placed on each side of the fire-box.

Regulator.—Piston valve regulator, as illustrated and described in detail in The Artizan of April last, to suit a main steam pipe, 4$\frac{1}{2}$in. in diameter.

Frames.—Single inside plate frames, 4ft. apart ; 10in. deep over driving fork, and 1$\frac{1}{8}$in. thick ; made of best Yorkshire iron.

Wheels and Axles.—Wheels, six in number, made of solid wrought iron ; driving and trailing wheels, 6ft. 1in. diameter, with tyres 5in. broad × 2in. thick, made of Krupp's steel ; leading wheels, 3ft. 7in. diameter ; driving and trailing axles, 6$\frac{1}{2}$in. diameter × 7in. long in journal, and 6$\frac{3}{4}$in. diameter in the body, and made of Krupp's steel ; leading axle, 6$\frac{1}{2}$in diameter × 6$\frac{1}{2}$in. long in journal, and 6$\frac{1}{2}$in. diameter in body ; made of the best Yorshire iron.

* We are unavoidably prevented giving Plates 255 and 256 with the present number. They will be issued with the next number, to be bound up with the 1863 volume.

As a remarkable instance of the performance of Krupp's steel, Mr. Sinclair mentions that some driving and trailing wheel tyres have run from 60,000 to 70,000 miles without being turned.

Wheel Base.—Between leading and driving wheels, 6ft. 1in ; between driving and trailing wheels, 9ft. ; total, 15ft. 1in.

Springs.—Driving and trailing springs, 3ft. 3in. span, made of seven plates 5in. broad × $\frac{1}{2}$in. thick, connected by means of compensating lever. Leading spring 2ft. 6in. span, made of nine plates $\frac{3}{8}$in. thick and 5in. wide in centre, tapered to 4in. at the ends.

Weight of engine in working order: — On leading wheels, 10 tons 7cwt. 1qr. ; on driving wheels, 10 tons 7cwt. 3qr. ; on trailing wheels, 10 tons 1cwt. ; total, 30 tons 16cwt. The engine carries a small tank under the foot plate in order to increase the weight upon the trailing wheels.

Width of engine over all, 8ft. 1in. ; length over all, 26ft. 9in.

Figures 5, 6, 7, and 8 represent one of the four-wheel coupled express engine, as made by Messrs. Fairbairn & Sons, for the Manchester, Sheffield, and Lincolnshire Railway, upon the general design furnished by Mr. Sacré, the engineer of the line, modified in the frame connections, to realise the advantages of direct traction through the frames, independently of the boiler. These engines are daily running express trains upon gradients, varying from 1 in 100 to 150 and 200, with 8 and 10 carriages, at a rate of consumption of 20lbs. of coal per mile, from the South Yorkshire district.

The following are their main dimensions and leading features :—

Boiler Barrel.—10ft. long × 3ft. 8in. diameter ; made of $\frac{1}{2}$in. plates, double rivetted in the longitudinal seams ; height of centre of barrel from level of rails, 6ft. 1$\frac{1}{2}$in.

Fire-box Shell.—5ft. 2$\frac{1}{2}$in. long × 3ft. 11in. wide, projecting 7in. above the crown of the barrel ; made of $\frac{9}{16}$in. plates ; two 3$\frac{1}{2}$in. common safety valves, screwed down by means of spring balances, are placed on the crown of the shell.

Fire-box.—4ft. 6$\frac{1}{4}$in. long × 3ft. 3in. wide × 5ft. 3$\frac{1}{2}$in. deep ; made of $\frac{9}{16}$in. copper plates, excepting the tube plate, which is $\frac{7}{8}$in. thick ; two rows of hollow stays are provided at the front of the box, with the object of assisting in the combustion of coal.

Heating Surface.—150 brass tubes, 10ft. 3$\frac{1}{4}$in. long × 2in. diameter = 806·25 square feet ; fire-box = 92·25 square feet ; total, 898·5 square feet.

Grate Area.—4ft. 6in. × 3ft. 3in. = 11·62 square feet ; fire-bars and frame of the ordinary construction.

Smoke-box.—2ft. 5in. wide × 2ft. 3in. radius ; made of $\frac{1}{4}$in. plates.

Chimney.—16in. diameter × 13ft. 3in. high, measured from level of rails.

Cylinders.—Inside, 16in. diameter × 22in. stroke, 1$\frac{1}{4}$in. thick in the body ; steam ports, 14in. long × 1$\frac{1}{2}$in. wide ; exhaust port, 3$\frac{1}{4}$in. wide ; lap of valve, 1$\frac{1}{4}$in. ; blast orifice, 4$\frac{1}{2}$in. diameter.

Link Motion.—Shifting link, 16in. long, with valve-rod suspension 13in. behind the link ; eccentrics, 5$\frac{1}{2}$in. throw.

Connecting Rod.—5ft. 9in. long ; bearing in cross head pin, 3in. diameter × 3in. long ; bearing in crank 8$\frac{1}{2}$in. diameter × 4in. long ; outside crank pins, forged solid with the crank, 2$\frac{3}{4}$in. diameter × 3$\frac{1}{4}$in. long.

Feeding Apparatus.—Two long stroke pumps, bolted against the inside frame, and worked from cross head ; plunger, 1$\frac{1}{2}$in. diameter ; pump barrel made of brass.

Regulator.—Horizontal slide valve regulator placed inside the smoke-box, and worked by means of a handle moving in helical grooves.

Frames.—Inside and outside frames ; the inside ones are single plates, 12in. deep over driving fork × 1in. thick, placed 4ft. apart ; the outside ones are made of a balk of pitch pine, 13$\frac{1}{2}$in. deep over driving forks × 3$\frac{1}{2}$in. thick, lined with two plates $\frac{7}{16}$in. thick ; distance from centre to centre 6ft. 5$\frac{1}{4}$in.

Wheels and Axles.—Wheels, six in number, made of solid wrought

iron; driving and trailing wheels coupled, 6ft. diameter; leading wheels, 4ft. diameter; tyres, $5\frac{1}{4}$in. broad × 2in. thick; the axles have all double conical outside journals; trailing and driving axles, 6in. and 7in. diameter × 9in. long in outside journals, and $6\frac{1}{2}$in. diameter in body; inside journals of driving axle, $6\frac{1}{2}$in. diameter × 5in. long; leading axle, $4\frac{3}{4}$in. and $5\frac{1}{2}$in. diameter × 10in. long in journals, and $5\frac{1}{2}$in. diameter in body; driving and trailing axle boxes of brass, with wrought iron straps cast into them; leading axle boxes of cast iron with brass step.

Wheel Base.—Between leading and driving wheels, 7ft. 9in.; between driving and trailing wheels, 7ft. 3in.; total, 15ft.

Springs.—Leading, trailing, and outside driving springs, 3ft. span, made of 16 plates, $\frac{7}{16}$in. thick × $3\frac{1}{2}$in. wide; inside driving springs, 2ft. 9in. span, made of 12 plates, $\frac{7}{16}$in. thick × $3\frac{1}{2}$in. wide.

Width of engine over all, 8ft. 8in.; length over all, 25ft. 6in.

Figures 1, 2, 3, 3, 4, and 5, Plate 254 given herewith, represent one of the six-wheel coupled luggage engines, made at the works of Graffenstaden, near Strasburg in France, under the superintendence of Mr. J. Mesmer, engineer, for the Northern Railway of France. We have not been furnished with the particulars of the actual performance of these engines, but from the knowledge we have of the management of goods traffic on the continent, we may state that they are intended to draw very heavy loads at speeds probably not exceeding 15 miles per hour.

Their main dimensions and leading features are as follows:—

Boiler Barrel.—12ft. $1\frac{1}{2}$in. long × 4ft. diameter; made of $\frac{7}{16}$in. plates, single rivetted.

Fire-box Shell.—Flush at the crown with the barrel, 4ft. 7in. long × 3ft. $7\frac{3}{8}$in. wide below the centre of the barrel; made of $\frac{1}{2}$in. plates; height from rails to centre of barrel, 6ft. $4\frac{5}{8}$in. Two safety valves, 4in. diameter, screwed down by means of spring balances, are placed upon the crown of the shell.

Fire-box.—4ft. 2in. long × 3ft. $\frac{1}{2}$in. wide × 5ft. $1\frac{5}{8}$in. deep; made of $\frac{1}{2}$in. copper plates, excepting the tube plate, which is 1in. thick.

Heating Surface.—143 tubes (brass) 12ft. 4in. long × $2\frac{1}{16}$in. diameter = 845 square feet; fire-box, 72·36 square feet; total 917·36 square feet.

Area of Fire Grate.—$12\frac{1}{2}$ square feet; there are 21 fire bars placed at a small angle to promote the consumption of smoke; besides these there are three transverse bars (the former not extending over the full length of the box), which may be readily removed by means of a handle and levers worked from the foot plate, to facilitate the operation of drawing the fire.

Smoke-box.—2ft. $8\frac{5}{8}$in. long, of same diameter as the barrel of which it forms a prolongation. It contains a light wrought-iron grating to prevent any cinders being carried away by the force of the blast.

Chimney.—$15\frac{1}{2}$in. diameter × 13ft. $9\frac{1}{4}$in. high, measured from the level of the rails.

Cylinders.—Inside, 15in. diameter × 24 in. stroke; fitted with wrought iron piston, having packings somewhat similar to Ramsbottom's. Steam-ports, $10\frac{1}{4}$in. long × $1\frac{1}{2}$in. wide; exhaust port, $2\frac{5}{16}$in. wide; lap of valve, $1\frac{3}{16}$in. at front, and $1\frac{1}{32}$ at back; double exhaust pipe provided with wing valve, for regulating the blast; blast orifice, $3\frac{3}{16}$in. diameter.

Link Motion.—Shifting link, 17in. long; throw of eccentrics, $4\frac{1}{4}$in.

Connecting Rod.—Forked, 4ft. $9\frac{1}{2}$in. long; cross-head pins, $2\frac{13}{16}$in. diameter × $2\frac{5}{16}$in. long; bearing in crank, $6\frac{5}{16}$in. diameter × 4in. long; crank pin journals, $2\frac{13}{16}$in. diameter × $3\frac{3}{8}$in. long.

Feeding Apparatus.—Two cast-iron pumps, $4\frac{3}{16}$in. diameter × $4\frac{1}{2}$in. stroke, worked from the same eccentrics as the link motion; and one Giffard's injector placed horizontally on the foot-plate against the side of the fire-box.

Regulator.—Horizontal slide-valve regulator, placed on the crown of the barrel, with 4in. steam-pipes leading to the cylinders, round the outside of the barrel, on each side of it.

Frames.—Single inside plate frames, 8in. deep × $1\frac{3}{16}$in. thick, placed 3ft. 11in. apart, with double axle-forks rivetted to them.

Wheels and Axles.—Six wheels, made of solid wrought-iron, 4ft. 8in. diameter, all underneath the boiler; tyres, $5\frac{1}{4}$in. wide × 2in. thick; driving axle, $6\frac{1}{2}$in. diameter × $6\frac{1}{4}$in. long in journals, and $6\frac{1}{2}$in. diameter in body; leading and trailing axles, $6\frac{5}{16}$in. diameter × $7\frac{1}{4}$in. long in journals, and $5\frac{11}{16}$in. diameter in body; axle boxes of wrought-iron with brass steps.

Wheel Base.—Between leading and driving wheels, 5ft. 11in.; between driving and trailing wheels, 5ft.; total, 10ft. 11in.

Springs.—All 3ft. 1in. span, composed of 14 plates, $\frac{13}{32}$in. thick × $3\frac{9}{16}$in. broad.

Weight of Engine in Working Order.—On leading wheels, 6·77 tons; on driving wheels, 8·25 tons; on trailing wheels, 9·98 tons; total, 25 tons.

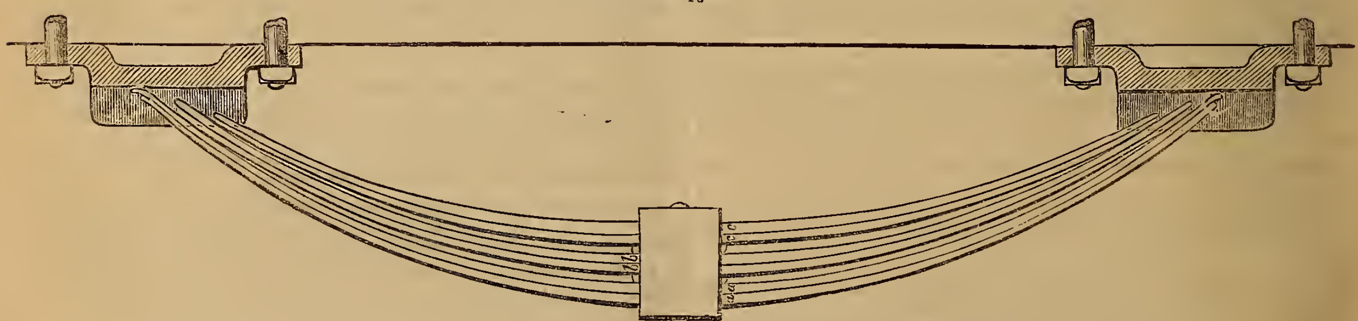
Width of engine over all, 8ft. $6\frac{1}{4}$in.; length over all, 24ft. $3\frac{1}{4}$in.

In our paper on the steam engine proper (Artizan, April last), we have described and illustrated in detail the leading parts of the locomotive engine such as they are generally made in this country; and as we have illustrated in the accompanying plate, a very fair type of a continental engine, we have, in order to enable the reader to compare the construction of the detailed parts of the same with those made according to the practice of English engineers, given in Plate 255 some of the details thereof. Figs. 1 to 9 illustrate the connecting rod in detail; Fig. 10 the body of the piston, made of wrought iron, stamped solid; Fig. 11 illustrates the crosshead; Figs. 12 and 13 the eccentrics and rods, in which it will be noticed that the two sheaves are cast in one; and Figs. 14 and 15 illustrate the regulator. This latter part is a somewhat complicated casting, and the propriety of conducting the steam to the cylinders through pipes creeping round the boiler barrel outside seems to us very questionable, both on economical and on æsthetical grounds, with inside cylinders especially; this practice, however, is very prevalent abroad.

In our paper on the carriage treating of the wheel base and of the distribution of the load, in The Artizan of May last, we have illustrated various specimens of engines with the four hind wheels coupled, all taken from recent practice. Since then, Mr. Alexander Allan, who is well known in the locomotive world, has written to us, informing us that he was the first, at any rate in this country, to adopt this class of engines, which is gaining very much in favour now, and we have deemed it right here to record this fact in order to avoid misapprehension. Since the publication of our paper on springs, Mr. Allan has sent us also a drawing of an improved waggon spring, in which the object aimed at is constant sensitiveness under varying loads; and it seems to us evident, at first sight, that this object cannot but be realised here. The spring has already been adopted by various engineers, and, on the score of durability, appears to have given general satisfaction. We give an illustration of this spring in the accompanying woodcut.

Six Ton Waggon Spring for Variable Loads.

Scale $\frac{1}{16}$th.



2 plates 36in. long + 4in. wide, $\frac{5}{8}$ at centre + $\frac{3}{16}$ at ends.
2 plates 32in. " " "

2 plates $28\frac{1}{2}$ in. long + 4in. wide, $\frac{5}{8}$ at centre + $\frac{3}{16}$ at ends.
Weight of Spring with buckle 69lb.

If now we cast a rapid glance upon the growth and progress of locomotive engineering, we find that, at the dawn of the present century, the problem was scarcely broached; and if some vague ideas concerning it were entertained in the minds of a few, these few were probably looked upon as wild dreamers by the sober many, believers in Pope's philosophy that *whatever is, is right,* and therefore should remain so; while at the same time the attempts to put them into a tangible shape, when compared with the ultimate impersonation of those ideas, are characterised with a crudeness which is scarcely observable in the early examples of the stationary engine, some of which, though dating back to the latter quarter of last

century, still contrast very favourably both in stateliness of proportions and in economic working with the most recently promulgated ideas on this branch of engineering. The great saving, however, effected upon iron tramroads in the mineral traffic of the northern districts, by the introduction of inclined planes and stationary engines (the expense being only $\frac{1}{37}$th of that by horses upon wooden tramroads) could not but foster the desire to realise the same economy in the traffic between places more remote from each other, and was likely to keep at work the intelligence of the inventive few immediately connected with mining works or with mining interests. The invention of spinning machinery, which may be said to be coeval with that of the steam engine, and which from the beginning of this century also has been the cause of that rapid development taken by the various industries in textile fabrics which still remains a matter of wonder and of curious speculation to the minds of economists —this circumstance also seems to have acted as a great stimulant to the search for a power of locomotion affording the means of swifter transit than that afforded by common roads, or even by canals. It seems to us, however, a singular fact that, although railway traffic was widely spread in the northern coal district (the Stockton and Darlington Railway being the oldest one extant of any considerable length), yet has the locomotive appeared, as it were, to accommodate the wants of the cotton trade, at a time too when Manchester and Liverpool were connected by a canal affording the cheapest mode of transportation known to the present day; and our astonishment is still enhanced when we remember that the locomotive, which fulfilled the conditions of the problem offered for solution, is the contrivance of one who had been all his days connected with that mineral traffic of the north. This circumstance, however, seems to point to the fact that the transit of goods for the more immediate want of man, and the intercourse of individuals engaged in the traffic with the same, has a natural claim to precedence over any other interests, how important soever in its ultimate bearings upon the welfare of mankind.

It is needless here to reproduce in detail the incidents connected with that trial of engines at Rainhill, which, after the fruitless attempts of a quarter of a century, was the means of giving a practical shape to, and of turning into reality, that which until then had only existed as a dream, or, at best, as a something that ought to have reality. These circumstances have all been duly chronicled, and there is scarcely a mechanic to be found who is not acquainted with them in a general way, while the result of that trial is a living, omnipresent fact which has become part and parcel of human existence on earth, alike on the banks of the Tyne and in the plains of Hindostan—along the rapids of the St. Lawrence and in the prairies of the Brazils No human enterprise, we believe, either of the present or of any previous age, offers a more striking illustration of the well-known fact how great things may rise from small beginnings than that of railway communication; for while it may be said that in 1829, commercially speaking, railways did not exist, in 1862 they had reached in the British Isles alone a development of 11,550 miles, with a revenue of £29,128,550 sterling; and the aggregate development of the railways all over the world probably does not fall short of 25,000 miles, necessitating the maintenance of 12,000 locomotive engines, which alone represent a capital of £24,000,000 sterling. When Stephenson returned home victorious from that trial at Rainhill, sanguine though his hopes may have been as to the ultimate results of his labours, yet we presume these hopes must have been very modest indeed when compared with the figures just quoted. And such has been the case also with regard to the performance of the engine itself; for though Stephenson was laughed at when stating that he expected to be able to run at the rate of 13 miles an hour, yet is it no uncommon thing now, and quite practicable, to travel at five times that speed.

It is a gratifying circumstance to know that, unlike many other inventors or discoverers in branches of human industry or knowledge no less important than the one of which we have been treating here, the Stephensons have not become victims to this world's ingratitude, but that in their lifetime they have been partakers of a share of power and of wealth commensurate with the benefits for which the human race has been in a great measure indebted to them, while in their death their memory has been perpetuated, and their ashes honoured by being laid alongside with the greatest in the land. Great indeed is the contrast between the fate of the Stephensons and that of Crompton, in the art of spinning, of Jacquard, in the art of weaving, or of Cort, in metallurgy; but this contrast may not be unprofitable to the young ones among our readers, by way of teaching them that, although undeserved disappointments are of frequent occurrence, yet are there bright exceptions to this rule which ought to stimulate us all to persevere and conquer.

Having thus completed our task, we now have to perform the pleasing duty of publicly returning our thanks to those gentlemen who have favoured us with their assistance; among whom we should mention Messrs. Sharp, Stewart, and Co., Mr. Sinclair, Mr. Ramsbottom, Dr. Rankine, and Dr. Fairbairn, to whose ready answers to our several requests our readers are indebted as much as to our own labours for the interesting, and, we trust, useful information, which we have been able to lay before them.

GOODS LOCOMOTIVE "STEIERDORF."

CONSTRUCTED AT THE WORKS OF THE I. R. AUSTRIAN STATE RAILWAY COMPANY, VIENNA.

(*Continued from page* 252.)

Let A (Fig. 17) be the tender axle, C the false axle, $a\,m''' = a'\,m'' = l \cos \alpha$ the horizontal projections of the curves; the length $m'''\,m'' = y$ will have to be determined upon. The horizontal projections $a\,m'''$, $a'\,m''$ of the circles which the cranks move in from an angle ϕ, as will be seen by

Fig. 17.

drawing $a'\,z$ parallel to $a\,m'''$. If we make $a'\,z = a'\,m''$, the actual length $m'''\,z$ will be $= a\,a' = L'$, and the required length $m'''\,m''$ may then be determined by the triangle (in the space) $m''\,m'''\,z$. This triangle will be a rectangular one, both in the space and projection, as $m''\,z$ is perpendicular upon $m'''\,z$.

The angle

$$m'''\,z\,a' = m'''\,a\,a' = \tfrac{1}{2}\,\phi,$$

$$\therefore m''\,z\,a' = \tfrac{1}{2}\,(180^\circ - \phi) = 90^\circ - \tfrac{1}{2}\,\phi$$

$m''\,m'''$ being the hypothenuse, we have

$$m''\,m''' = \sqrt{\overline{m''\,z}^2 + \overline{m'''\,z}^2}.$$

As

$$m'''\,z = L',\ m''\,z = 2\,l \cos \alpha \sin \tfrac{1}{2}\,\phi = l \cos \alpha \sin \phi$$

we have

$$y = \sqrt{L'^2 + l^2 \cos^2 \alpha \sin^2 \phi} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

The angle α in this formula being variable, the length of the draw-bar will also be variable while the crank revolves.

When

$$\alpha = 90^\circ \text{ or } = 270^\circ,\ \cos \alpha = o$$

consequently,

$$y = L' \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

i.e. when the crank occupies a vertical position, the length of the draw-bar will be equal the distance of the centres of the crank circles.

If, however, $\alpha = 0$ or $= 180^\circ$, *i.e.*, when the cranks are in a horizontal position, $\cos \alpha = 1$; therefore, if we call L'' the highest value of y, we have

$$L'' = \sqrt{L'^2 + l^2 \sin^2 \phi} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

As the two cranks on both sides of an axle (*i.e.*, both the false axle and the tender shaft) are at an angle of 90°, we have, if for the one crank

$$y = \sqrt{L'^2 + l^2 \cos^2 \alpha \sin^2 \phi}$$

$$\alpha' = 90^\circ + \alpha\ \cos^2 (90^\circ + \alpha) = \sin^2 \alpha$$

consequently, for the other crank,

$$y' = \sqrt{L'^2 + l^2 \sin^2 \alpha \sin^2 \phi}.$$

The difference of the length of both draw-bars will therefore have to be

$$y - y' = \sqrt{L'^2 + l^2 \cos^2 \alpha \sin^2 \phi} - \sqrt{L'^2 + l^2 \sin^2 \alpha \sin^2 \phi}.$$

If $\alpha = 0$ or $= 180^\circ$, $\sin \alpha = 0$, consequently,

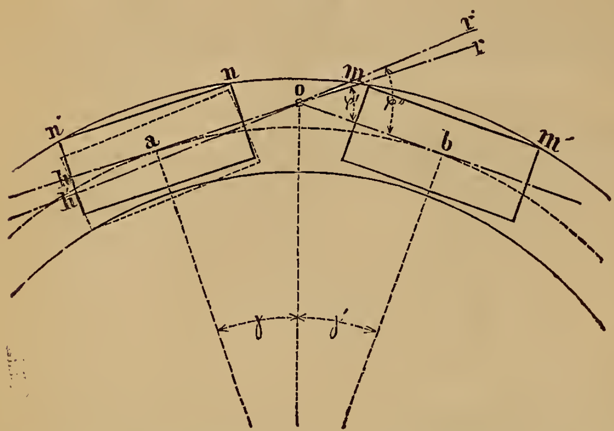
$$y - y' = \sqrt{L'^2 + l^2 \sin^2 \phi} - L' \quad . \quad . \quad . \quad (11)$$

If, however, $\cos^2 \alpha = \sin^2 \alpha$, *i.e.*, if $\alpha = 45°$ or $135°$, we have

$$y - y' = L' - L' = o \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

To find, finally, the value of the angle ϕ, upon which the value of all the other expressions depend, let b (Fig. 18) be the axis of the engine frame, a the axis of the tender frame, both frames to be connected in 0;

FIG. 18.



$m\, m'$ the outside wheels of the engine frame, $n\, n'$ the outside wheels of the tender frame, $\gamma\, \gamma'$ the angles at the centres, corresponding to the lengths $a\, o$ and $b\, o$.

If the engine works regularly, and the carriage next to the tender is connected with the tender as the latter is with the engine, the wheels $m\, m'$ $n\, n'$ will touch the outside rails with their brims, and the angle of the frames, which we will term ϕ', will be equal the angles at the centre, *i.e.*,

$$\varphi' = \gamma + \gamma'.$$

These angles being very small, their tangents may be substituted for them, and then we shall have

$$\varphi' = \frac{o\, a}{R} + \frac{o\, b}{R} = \frac{\frac{1}{2}\, D + \Delta}{R} + \frac{\frac{1}{2}\, D' + \Delta'}{R}$$

(see Fig. 15); or, since in the locomotive "Steierdorf," $D = D'$, $\Delta = \Delta'$

$$\varphi' = \frac{D + 2\,\Delta}{R} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

If, however, the train is connected with the tender by a common chain, the back wheel of the tender running on the outside rails will tend to leave them, and thus the angle ϕ' will be increased by a quantity $h\, o\, h'$; and, if we term the increased angle ϕ'', we have

$$\varphi'' = \varphi' + h\, o\, h'$$

$$h\, o\, h' = \frac{h\, h'}{h\, o} = \frac{v + w}{D + \Delta}$$

$$\therefore \varphi'' = \frac{D + 2\,\Delta}{R} + \frac{v + w}{D + \Delta} \quad . \quad . \quad . \quad . \quad . \quad (14)$$

The valve of φ'' is the utmost the angle of the engine and tender can reach during the normal working of the locomotive. To find its value in degrees and minutes, that given in 13 and 14 has to be multiplied by formula $\frac{180}{\pi}$.

The numerical values relating to Figs. 15 and 18 may be taken from the table of dimensions (THE ARTIZAN, March 1, 1863, pages 49 and 50), viz.:—

$D = D' = 7$ft. 3·1189in.	$L = 2$ft. 0·8911in.
$\Delta = \Delta' = 2$ft. 4·5210in.	$M = 4$ft. 1·7822in.
$2\, l = 2$ft. 0·8911in.	$N = 3$ft. 10·9301in.
$E = 2$ft. 11·5217in.	$R = 373$ft.
$F = 3$ft. 5·4852in.	$v = 1$·2446in.
$K = 5$ft. 2·2278in.	$w = 0$·5186in.

The inclination of locomotive and tender, for a curve of 373ft. radius, will then be, according to

Formula 13 . . . $\varphi' = 1° 51'$
" 14 . . . $\varphi'' = 2° 43'$

For the same curve, the values denoted by the foregoing formulæ will be as follows:—

Formula.	Expression.	Numerical values for Curves of 373ft. radius.	
		If $\varphi = 1° 51'$	If $\varphi = 2° 43'$
No.		Inches.	Inches.
1	$\Delta \sin. \varphi$	·9208	1·3518
2	$F - \sqrt{K^2 - \Delta^2 \sin.^2 \varphi}$	·0102	·0220
3	$K - \sqrt{K^2 - \Delta^2 \sin.^2 \varphi}$	·0068	·0147
4	$F - K - \sqrt{T^2 - \Delta^2 \sin.^2 \varphi} + \sqrt{K^2 - \Delta^2 \sin.^2 \varphi}$	·0034	·0073
5	$\sqrt{L^2 - E^2 \sin.^2 \varphi}$	24·8640	24·8334
6	$\sqrt{L^2 + (N^2 - E^2) \sin.^2 \varphi}$	24·9108	24·9335
7	$\sqrt{L^2 + (N^2 - E^2) \sin.^2 \varphi} - L$	·0197	·0424
9	$y = L'$	24·9108	24·9335
10	$\sqrt{L'^2 + l^2 \sin.^2 \varphi}$	24·9140	24·9405
11	$\sqrt{L'^2 + l^2 \sin.^2 \varphi} - L$	·0032	·0070
12	$y - y' = o$	0	0

The result obtained from these and further calculations as to the condition of the arrangement of the draw-bars in curves, proves to be the following:—

1st. When the frames become inclined towards each other in crossing a curve, the draw-bars and coupling gear will take up a position oblique to their previous one; this necessitates the employment of ball and socket connection of both frames.

2nd. The coupling apparatus can be constructed so that the length of all connecting and coupling rods, on crossing the curve, correspond with mathematical exactitude with the points to be connected, except a lengthening and shortening of the draw-bars between the false axle and the coupling axle of the tender during the revolving of the cranks; this difference, however, amounting only to ·0067in. in curves of 373ft. radius, may be neglected, considering the unavoidable allowance at the points of coupling and the elasticity of the material employed.

3rd. The same defect exists with respect to the engine shaft, since on crossing a curve the false axle approaches the engine shaft more than the shortening of the oblique draw-bars between the driving shaft and the false axle tree purports. The maximum of difference is here likewise = ·0067in., which may of course be neglected.

A further defect consists in the increase of the distance of the centres of the crank circles between the false axle and the coupling shaft on crossing a curve; the maximum of this error amounts to ·0409in. This error, should it prove injurious, may be rectified by means of a joint to be employed on the vertical connecting bar between the false axle and the coupling shaft.

The trial journeys to which the "Steierdorf" was subjected last year proved very successful. Notes taken on this occasion show that gradients up to 1 : 40 and curves down to 103 yards radius can be traversed without disturbing the moving parts.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, NEWCASTLE, 1863.

ON BOILER EXPLOSIONS.

Mr. P. le Neve Foster read a paper on this most important subject by the Astronomer Royal. It stated—In considering the cause of the extensive mischief done by the bursting of a high pressure steam boiler, it is evident that the small quantity of steam contained in the steam chamber has very little to do with it. That steam may immediately produce the rupture, but as soon as the rupture is made and some steam escapes, the pressure on the water is diminished, a portion of the water is immediately converted into steam at a slightly lower temperature and lower pressure; and this, in the same way, is followed by other steam of still lower temperature and pressure, and so on, till the temperature is reduced to 212° F., and the pressure to 0. Then there remains in the boiler a portion of the water at the boiling point, the other portion having gone off in the shape of steam of considerably diminishing pressure. From this it is evident that the destructive energy of the steam, when a certain pressure is shown by the steam-gauge, is proportional to the quantity of water in the boiler. By the assistance of Professor Miller, of Cambridge, Messrs. Ransome, of Ipswich, and Geo. Biddell, Esq., I have been able to obtain a result which I believe to be worthy of every confidence. I will first state as the immediate result of Mr. Biddell's experiments, that when there were in the boiler of a small locomotive 22 cubic feet of water, at a pressure of 60lbs. per square inch, and the fire was raked out, and the steam was allowed gently to escape with perfect security against priming, the quantity of water which passed off before the pressure was reduced to 0, was $2\frac{3}{4}$ cubic feet or $\frac{1}{8}$ of the whole. In regard to the use made of Professor Miller's theory, Professor Miller had succeeded in obtaining a numerical expression of the pressure of the steam at twelve different measures of the volume occupied by water and steam, which expression I have succeeded in integrating accurately, and I have thus obtained an accurate numerical expression of the destructive energy of the steam. In regard to the use of General Didion's experiments, these experiments give the velocity of the ball, in cannon of different sizes, produced by different charges of powder. I have found by trial which of these experiments exhibit the greatest energy per kilogramme of powder, and have adopted it in the comparison. The result was as follows:—The destructive energy of one cubic foot of water at 60lbs. pressure per square inch, is equal to the destructive energy of two English pounds of gunpowder, in General Didion's cannon experiments. Gen. Didion's experiments were made, as I understand, with smooth bored cannon. It cannot be doubted that much energy is lost in the windage; some also from the circumstance that the propelling power ceases at the muzzle of the gun before all the energy is expended, and some from the coolness of the metal. If we suppose that, from all causes, one half of the energy is lost, then we have this simple result. The gauge pressure being 60lbs. per square inch, one cubic foot of water is as destructive as one pound of gunpowder. In one of Mr. Biddell's experiments, the steam valve was opened rather suddenly, and the steam escaped instantly with a report like that of a very heavy piece of ordnance. This is not to be wondered at, for it appears from the comparison above that the effect was the same as that of firing a cannon whose charge is 41lbs. of powder.

Mr. Wm. Fairbairn, F.R.S., said he himself had paid considerable attention to the subject of boiler explosions, and he was glad to find that Professor Airey had drawn attention to it. It was a most important subject, as about 150 persons were killed annually from boiler explosions. That was the reason they had formed an association in Manchester for the purpose of preventing boiler explosions. It had now been in operation for about eight years, and he believed there had only been one or two lives lost during that time by the explosion of boilers under the inspection of this association; whereas in other parts not under the inspection of this association, there had been two or three explosions lately. This association had done a large amount of good by preventing accidents of this kind; and he would earnestly recommend the establishment, in a district like that around Newcastle, where they had so many boilers in operation, of a similar association. He merely mentioned those facts to show that people having boilers should associate themselves for the purpose of preventing explosions, otherwise the Legislature might interfere to establish a system of inspection not so pleasant to those having boilers under their charge.

BOWN'S PATENT TYRE FASTENING.

The following is extracted from the paper read by Mr. Fothergill upon this subject:—

On each side of the rim of the wheel is turned, at the outer edge, an angular or undercut groove, leaving a dovetail projection on the outer periphery thereof. The tyre is formed of a diameter about $1\frac{3}{4}$in., or 2in. larger than the rim it is intended to embrace, and has also two angular or undercut grooves turned out of the edges of its internal circumference, leaving a dovetailed projection similar to that on the rim; two wrought iron securing rings are then turned with angular projections corresponding to the augular grooves of the rim and tyre. One of these rings being laid down with the projections upwards, the wheel rim is placed upon it with one of its grooves taking the internal projection of the ring; the tyre then being laid with one of its grooves corresponding to the outer projection of the ring, an annular space of $\frac{7}{8}$ to 1″ will be left all round between the rim and tyre; the other securing ring is then dropped into the grooves on the upper side of the tyre and rim respectively, and finally bolts are passed through the two securing rings and through the annular space left between the tyre and rim; these, being screwed up with nuts on the outer side of the wheel, hold the whole firmly together, and form a most compact and simple tyre fastening.

The first and most important advantage claimed for this system over the ordinary tyre fastening is its perfect safety; for, should the tyre become loose, or even were it to break into a number of pieces, no portion of it could possibly leave the wheel, for the securing rings would still have a firm hold of the dovetail projection on each piece of the tyre, and no force much short of the ultimate strength of the section of the two rings through the bolt holes could ever fracture them. This power could never be attained by the centrifugal force of a portion of a broken tyre carried round by the wheel, however fast it might be revolving.

Secondly, a large proportion of the accidents arising from broken tyres, occur during the period of severe frosts, when the contraction of the iron, due to the great reduction of temperature, is productive of a still further increase to the strain already exerted by the initial "shrinkage" of the tyre, and is owing to there being no provision made in the ordinary method of fastening to allow for this contraction and expansion. In this system of fastening, on the contrary, each part is possessed of a certain amount of elasticity, which, by the peculiar construction, admits of the contraction and expansion of one part without danger of fracturing any of the rest; each part also is so arranged that it is subject to the same degree of expansion and contraction as its neighbouring part, so that there can never be any severe opposition of forces due to that cause, tending to break any of the weaker parts of the wheel.

Thirdly, in consequence of the tyre not being shrunk on, as in the ordinary manner, but fixed to the wheel in a cold state, the malleable qualities of the iron are preserved quite unimpaired, and crystallisation (a frequent consequence of the heating and shrinking) is entirely prevented.

Fourthly, the injurious degree of constant tension is altogether obviated, as, instead of there being always a force tending to break the tyre, the force, as applied to this wheel, draws it uniformly, by the action of the dovetails, towards the centre, and therefore all unnecessary strain is removed from the tyre.

Fifthly, should Bown's tyre become loose, it can be re-fastened with the greatest facility, as it is only necessary to tighten up the nuts on the bolts, so as to draw the securing rings more tightly into the dovetail grooves, and thereby hold the tyre more firmly.

Sixthly, its lightness and flexibility, combined with its strength, being adapted to obviate the breakage of axles, a by no means uncommon occurrence with wheels of extreme rigidity, constructed under the common system.

Seventhly, the readiness with which this wheel can be repaired, should any part of it become damaged, without the whole having to be condemned, is a very important advantage, in an economical point of view, as the whole is so readily taken to pieces, and other spare duplicate parts adjusted to replace those damaged. A most favourable comparison may be drawn in this particular between the patent and ordinary fastening, as will be seen from the following statement of the weights, cost, and time required to replace one bad tyre by each system:—

Diameter.			Patent Fastenings.						Ordinary Fastenings.						Time.	
			Weight.			Net Cost.			Weight.			Net Cost.			Patent.	Ordinary.
ft.	In.		C.	qr.	lb.	£	s.	d.	C.	qr.	lb.	£	s.	d.	hrs.	hrs.
3	6	Replacing one bad Tyre	3	0	3	3	1	8	3	2	19	3	11	0	2	4
3	1	Do. Do.	2	2	20	2	15	3	3	0	26	3	3	3	2	4

showing a saving in weight of 2qrs. 16lbs., of money, 9*s*. 4*d*., and of time 2 hours, for a wheel of 3ft. 6in. diameter; and of 2qrs., 6lbs. weight, 8*s*. in cost, and 2 hours of time for a wheel of 3ft. 1in. diameter. The difference in time is accounted for by the injured ordinary tyre having to be heated to get it off the rim, and the new ordinary tyre to get it *on* the rim; whereas, in the wheel under notice, the tyre is taken off and replaced by another by simply unscrewing the bolts, lifting off the old tyre, placing the new one, and re-screwing up the bolts.

Eighthly, the extreme simplicity of construction is productive of great advantages, when it becomes necessary to re-tyre the wheels, which is a very important feature in the maintenance of rolling stock. The following comparison will show that the weight of a set of tyres and the cost of re-tyring by the patent fastening is considerably less than that for one fastened by the ordinary method:—For re-tyring a set of 3ft. 6in. wheels by the patent method the tyres will weigh 12cwt. 0qrs. 12lbs., against 14cwt. 2qrs. 10lbs. by the ordinary, giving 2cwt. 1qr. 26lbs. in favour of the former; while the respective costs for re-tyring a set will be, by Bown's patent, as shown, £13 15*s.* 6*d.*, against £16 1*s.* 3*d.* by the ordinary, or a saving of £2 5*s.* 9*d.*, per set in wheels of that size; and for wheels of 3ft. 1in. diameter, the weight saved per set is 2cwt. 0qrs. 24lbs., and the saving in cost £1 18*s.* 11*d.*; or, for the larger wheels, 14 per cent., and for the smaller 13½ per cent. below the sums expended for that process in the ordinary way, an item of very great importance in an extensive system of rolling stock.

Ninthly, another considerable advantage gained by this improved tyre is that it can be efficiently and economically applied to other ordinary wheels, which are in use, after the tyres are worn down, without having recourse to the necessity of condemning one class of wheel in order to introduce one of more modern construction, as all that is required to adapt them to the new fastenings, is to turn the dovetailed grooves in the rim of the old wheel; and the new tyre, with its securing rings, are dropped into their respective places and secured with far greater facility than by any other method hitherto adopted. By this means wheels of any class may be utilized; even those which have been condemned and put out of use by railway companies, as being too small, may be increased in diameter to the extent of from two to five inches; and it will also be seen that a larger wheel can at all times be obtained by the use of this method, from which a considerable saving in tractive power and in the wear and tear of journals and brasses will be effected. The weight of tyres with fastening, and the net cost of preparing and securing one set of four tyres to old wheels ready for use, the tyres being put on cold, is, for a set of 3ft. 6in. wheels, weight 19cwt. 1qr. 4lb., and the net cost £11 4*s.*, for a set of 3ft. 1in. wheels, weight 14cwt. 2qrs., and the net cost £8 19*s.*

The question of durability, as compared with the ordinary wheel, also inclines in favour of the patent tyre, doubtless in consequence of the elastic nature of the fastenings resulting from the particular arrangement of the parts in respect to each other. An example or two will illustrate this. A pair of each kind manufactured by the Kirkstall Forge Company were placed under a break van, the tare of which was 9tons 3cwt., and after having made a mileage of 19,131 miles, the loss of weight in running that distance was, for the patent tyres 72lbs., and for the ordinary 96lbs., or 25 per cent. in favour of the former. A second pair of each, by the same makers, were placed under a break van, the tare of which was 9 tons, and after running 21,991 miles, the loss of weight sustained by the patent tyres was 30lbs. and by the ordinary ones 44lbs., or 31·8 per cent. again in favour of the patent tyres.

A large number of these wheels and tyres are now undergoing some of the severest tests possible in the regular course of railway working. There are already some 40 or 50 break vans furnished with patent tyres in constant work on the London and North-Western Railway. The pair under notice have been recently taken from under a break van running on the Chester and Holyhead line. The tyre of each wheel is cut into four segments, and is held in position on the periphery of the rim by no other means than those already described. In this condition they ran, between March, 1862, and June last, a distance of 46,973 miles. After running that distance, they were put into a lathe and the tyres turned up, and from that month to the 18th of the present they have run 8618 miles, making a total of 55,591 miles. The tare of the break van under which they were running is 7 tons 10cwt.

This is the most conclusive evidence of the perfect security assured by these wheels, as it is thereby demonstrated that, if even a tyre should be broken into several pieces, they will still be retained in their places; and no inconvenience whatever would be felt by the passengers, nor would a train be so much as detained. Other wheels of the same descriptions have run on the same line 80,000 miles under break vans, and some with tyres, only half an inch thick on the outside edge, have run upwards of 12,000 miles in that condition, which is perhaps the severest test to which a wheel could be subjected, and yet no single instance of failure has ever resulted from any one of these numerous trials.

The first cost of a complete set of wheels with Bown's patent fastenings is about that of the ordinary kind; but it must be borne in mind that in the former the expenses of repair and re-tyring are very materially less than is the case in the latter; therefore, proprietors of rolling stock would do well to consider the advisability of adopting such wheels, not only on the ground of safety, but also on that of economy; and no excuse hereafter can be satisfactorily advanced whenever any disaster may take place arising from the separation of a broken tyre from the body of a wheel.

ON THE APPLICATION OF MACHINERY TO COAL CUTTING.

By Samuel Firth.

Numerous efforts have been made during the last fifty years to bring coal cutting in mines under the influence of mechanical power, but in no case, I believe, except at the West Ardsley Colliery, has any continuous operation survived the experimental period. I do not expect that the introduction of machinery into coal mines for the purposes named would materially diminish the number of persons employed, but rather that the effect would be to meet the increasing consumption. That increase may safely be taken at two millions of tons per annum; and to supply that increase would require an annual increase of labourers, amounting to about 3500. Thus there will not be any violent displacement of labour.

The steam engine has a 20in. cylinder, and the air pump 18in. The air is worked at a pressure of about 50lb. to the square inch. The air is conducted down the shaft in iron pipes of 4in. diameter, and thence to the workings (about 800 yards) in gas piping, and down the face by India rubber piping of 1in. diameter, which is connected to the machine. The machine is moved on iron rails laid on cross iron sleepers, and is propelled a little, after each blow of the pick, by the handwheel. Generally the machine is passed three times over the face of the coal, each time with a longer "pick," to gain the requisite depth for taking down. The first cut being 18in. to 20in.; the second, 9in. to 11in.; and the third, from 6in. to 8in.; 36in. being the depth aimed at and accomplished. The actual quantity of work done in six consecutive days of eight hours each, by one man with one machine, was 618½ yards, or about 800 tons of coal.

The man is attended by two boys, who clean out the groove and remove the coal thrown out by the machine. In the West Ardsley seam a man will average 7½ yards of coal a day; so that, if the machine were worked by shifts of eight hours, three men and six boys would do the work of 40 men, and that, too, the most severe and trying work in the pit.

It must be understood that at West Ardsley the seam is somewhat favourable for the purpose. It is 4ft. thick, having a good roof and floor, and is worked on the *long wall* system, with a somewhat soft bareing part, about 12in. above the floor, and in this the pick works.

The machine thus far has only been put to "bareing" or "kirving," but the proprietors expect to effect "straight work" by a different arrangement of the picks. The filling and all other work of the pit is untouched by this machinery. The air power works admirably, and its use gives a cool and refreshing stream of pure air to the far distant works, which issues from the cylinder at a temperature very little above freezing point.

It will not be necessary to say here that the air power is acquired by a much larger measure of steam power; but this is not a material item at a colliery, where so much engine coal is almost worthless. I am not prepared with the exact commercial results or saving in cost, but at West Audsley this part of the question is, I believe, eminently satisfactory.

I have been informed that some experiments have been made, within the last few days, at the Hetton Colliery, by the West Ardsley machine; and although the seam is of a hard nature, the kirving was done 3ft. deep with a groove of 3in. at the face and 2in. at the back, giving an average cut of 2½in. high, whereas the average height of hand kirving in the same seam is about 11in.

INSTITUTION OF CIVIL ENGINEERS.

DESCRIPTION OF LIGHTHOUSES LATELY ERECTED IN THE RED SEA.

By Mr. W. Parkes, M. Inst. C.E.

Having been instructed by the Board of Trade to make the necessary preliminary surveys for establishing lights to facilitate the navigation of the northern portion of the Red Sea, the author recommended three sites, 1, Zafarana Point on the Egyptian shore, 50 miles from Suez; 2, the Ushruffee reef, on the western side of the navigable channel of the Straits of Jubal, 150 miles from Suez; and 3, the Dœdalus reef, in the centre of the Red Sea, 350 miles from Suez, and 180 miles from the entrance of the Gulf of Suez. These sites having been approved by the Egyptian Government, by the Board of Trade, and by the Directors of the Peninsular and Oriental Steam Packet Company, the immediate execution of the works was authorised, upon designs submitted by the author.

Zafarana Point being on the mainland, it was considered most advantageous to construct a tower and lightkeepers' dwellings of rubble stone, and to employ native labour entirely, under the direction of H. E. Linant Bey, the chief engineer of the Public Works department of the Egyptian Government. The design presented no feature calling for special remark, and the works had been carried out in a very satisfactory manner. The light was a fixed dioptric of the first order, visible, over five-eighths of a circle, at a distance of 14 miles. It was first exhibited on the 1st January, 1862.

The main features of the other sites were then described. The Ushruffee was a coral reef of which the sides sloped irregularly from the level of a few inches

under low water to a depth of from 8 to 10 fathoms, no part being above the water, and there being very little sand, even in the cavities of the coral. The Dœdalus reef was a submerged island, with a flat top of an oval form 1200 yards in length and 450 yards in breadth, the sides being generally vertical, or in some places even overhanging. The actual surface of the coral was about 6in. under low water; but there was a small shifting bank of sand near the south-east end, which was dry at low water, and sometimes also to a small extent at high water. The range of tide was about 2ft. at springs.

The peculiar conditions which had to be considered, in designing the proposed constructions, were—First, the force of the sea would be completely broken at some distance within the edge of the reef. Secondly, the structures would have to be built upon the surface of the reef, and not be sunk into it, as no additional security could be thus obtained, while the advantage of the natural platform would be lost. Thirdly, in the absence of any definite experience as to the actual weight which the reefs would bear without being crushed, it was desirable to keep the weight per superficial foot of foundation as low as possible. Fourthly, the buildings had to be designed so as to mitigate the intense summer heat. And fifthly, in the case of the Dœdalus, as the materials would have to be brought from Suez, and as there was no anchorage, it was necessary that a steamer should be employed, capable of keeping close to the reef in any wind, and of providing quarters for the workmen and storage room for the materials, until a proper depôt and habitation could be formed on the reef itself. These requirements rendered it essential that the materials should be small in bulk, that the several parts should be light and easily handled, and that the mode of putting them together should be as simple as possible.

It appeared to the author that these conditions would be best attained by adopting a structure of wrought-iron supported on teak piles, resting on and the feet bedded in a layer of concrete, so as to distribute the weight, the surface of the concrete being a little above the level of high water; and that by filling in the wrought-iron framework with strong corrugated iron, so as to form a series of rooms one above the other, as a central column with verandahs, or galleries, around each room, likewise partially enclosed, a portion at least of the sun's rays would be prevented from falling on the walls of the rooms, whilst there would be a free admission of air.

As the Dœdalus light had only to guard against the dangers of the reef on which it was placed, it was not necessary that that structure should exceed the limited height that would allow of four tiers of rooms, and of accommodation for the lighting arrangements. These together brought the light to an elevation of 62ft. above the mean level of the sea. As the Ushruffee light had to lead vessels past dangers 12 or 14 miles distant, a more powerful light, at a greater elevation, was required. The height fixed upon was 125ft. above the mean level of the sea. The framework was of the same description in both cases, but in the latter case there were eleven tiers, whereas in the Dœdalus there were only four tiers. Details were then given of the Ushruffee structure, as being the larger of the two. It was stated that this structure was supported upon eighteen piles, each 18ft. long and 18in. diameter, arranged in two concentric circles. The inner circle consisted of six piles and was 15ft. diameter, while the outer circle was formed of six pairs of piles (the piles of each pair being 6ft. apart), 37ft. diameter at the top, and the feet spread outwards at a batter of 1 in 12. The feet of the piles, resting upon the natural surface, and there were shoulders on each side of the piles, resting on sleepers of teak, bedded on the concrete 2 to 3ft. above the surface of the coral. The heads of the piles passed through circular wrought-iron collars, to which they were accurately fitted, and any loosening by the shrinkage of the timber was provided for, by fitting a number of wedges of greenheart timber into corresponding groves in the pile heads, in which they could be driven down when slack. A direct bearing surface was also given by iron screws 2in. diameter, which passed through each collar, and entered 2in. into the wood. The collars had projecting arms to which the bottom framing was riveted. The superstructure consisted of a repetition of three main parts, which might be called respectively standards, cills, and radiators. In each tier there were twenty-four standards, arranged in two concentric circles, and these were connected at the top and bottom by cills, thus forming two twelve-sided polygons, the corresponding angles of which were connected by the radiators. With the exception of a few parts near the bottom, no separate piece exceeded 4 cwt. in weight. The floors of the rooms were composed of cast-iron plates covered with concrete, and from the lowest floor there was suspended a hemispherical water tank, capable of holding 1500 gallons. The floors of the galleries were formed of open cast-iron gratings. The whole of the ironwork of the structure was erected on Messrs. Forrester and Co's. premises, at Liverpool, with the view of attaining the accurate fitting of the parts, and of testing its strength. While at its full height, with the exception of the piles at the bottom and the lantern at the top, but with the joints merely bolted together, it was exposed, in September and October, 1860, to two gales of wind of the registered force, respectively of 20·5 lbs. and 24·3 lbs. per square foot. There was no appearance of any straining of the joints, and a careful examination failed to discover any swaying movement at the top, though there was a sensible vibration. Since its erection on the reef it had been subjected to two severe gales, in June, 1862, and in January, 1863, with similar results; for although the top of the building had vibrated, there were no symptoms of straining having occurred.

The general principles of the construction of the Dœdalus lighthouse were the same as those of the Ushruffee, with such modifications as its smaller size demanded; thus there were only twelve, instead of eighteen piles, and the dimensions of the parts of the framework were the same as for the upper tiers of the Ushruffee. The building was stated to be very stiff, scarcely any vibration being perceptible under a strong breeze.

The lanterns were of the same construction for the three lighthouses. Those for the Ushruffee and the Zafarana, being for first order lights, were identical in every respect. That for the Dœdalus, being for a second-order light, was of reduced size. In construction, they were similar to those generally manufactured for the Trinity Corporation, but with special arrangements for mitigating the powerful effects of the sun. At the suggestion of Professor Faraday, a windguard was substituted for the ordinary revolving vane and cowl. The lanterns and light apparatus were furnished by Messrs. Wilkins and Co., the optical portion having been manufactured by Messrs. Chance, Brothers, whose improvements in lighthouse illumination deserved special notice. The Zafarana and the Dœdalus were fixed lights, while the Ushruffee had a revolving light frame.

The whole of the materials of the two iron lighthouses, and of the three lanterns and light apparatus, were, with some trifling exceptions, despatched from Liverpool within ten months from the date of the author receiving instructions to proceed to survey the sites, at a distance of nearly 3000 miles from Great Britain.

As the structures were designed with a special view to the peculiar circumstances of the sites upon which they were to be erected, it was considered desirable to give some account of the operation of erection. The Peninsular and Oriental Steam Packet Company granted, gratuitously, the services of the *Union*, a screw steamer of 300 tons and 60-horse power, the Egyptian Government paying for all wages, stores, and coal. The materials arrived at Alexandria on the 12th of November, 1860, but it was not until the 20th of December following that they were all received at Suez, and placed on board the *Union*, which then sailed for the Ushruffee reef. The expedition thus commenced was unfortunately not successful. The causes of the failure were given at length in the paper, but it would be sufficient to state the results of the season's labour, which lasted three months. The piles were erected on the reef, and their heads were connected by the bottom iron frame. The whole of the ironwork was landed, and laid out in order upon one of the neighbouring islands. This was not originally intended, as the plan decided upon was to moor the ship as near as possible to the reef during the progress of the works, and to land and sort the materials upon the concrete base of the lighthouse itself. After a full inquiry into the circumstances which had led to this failure, the author was instructed to make arrangements for a new expedition, and he readily assented to the suggestion that he should remain on the spot, until the operations as to which difficulty had been anticipated were completed. The permanent superintendence was intrusted to the late Mr. C. W. Scott (Assoc. Inst. C.E.), Captain W. Kirton being in command of the *Union*. As the materials had been landed on the Ushruffee Island, it was determined to form a land establishment for the working party there, rather than to quarter the men on board. This left the steamer free to carry a working party to the Dædalus, without interfering with the operations on the Ushruffee. The staff was re-organised, and the list of plant and of materials revised; but owing to several causes the operations were not resumed on the Ushruffee until the 8th November, 1861. The first step was to form the shore establishment. This occupied three weeks, owing to the want of skill of the native carpenters, in getting the huts ready for occupation. During this time, however, some progress had been made at the lighthouse. The caisson of iron plates to enclose the concrete base had been set up, and about 200 tons of gravel had been placed upon the reef, where it was exposed to a wash sufficient to remove some of the clayey particles. The process of depositing the concrete was then commenced, the plan adopted being to deposit it upon sheets of tarpaulin, which sunk with the weight and protected the soft material from the action of the water, until a mass of several tons was collected. When the whole space was covered in this way up to above low-water mark, the remainder was deposited, as the state of the tide allowed, until the whole height of 5ft. from the surface of the coral was complete. The first half of the concrete was formed of six measures of gravel to one of Portland cement, mixed in the lighters moored alongside the caisson. The second half was formed of lime, puzzuolano, and broken stone, in the manner usually practised in the country. The latter was mixed dry at Suez, and was wetted on being deposited.

When the success of the process of depositing the concrete was well assured, the author turned his attention to the Dœdalus, which was reached on the 26th of December. A site for the lighthouse was chosen near a small sandbank of triturated coral, as it was determined to use the sand for the concrete, and as it was also convenient for beaching boats, &c. The surface of this reef was very irregular, there being numerous hollow places, varying from 1ft. 6in. to 2ft. in depth. A four-legged shears was set up on the intended site, and a platform fixed upon it at the level of the underside of the pile collars. Upon this platform were bolted together the plates forming the polygon to complete the inner circle of piles. The six piles were then successively raised on end, and the collars were bolted to the polygon. When the six piles were fixed, the original stage was removed, and a new one was formed, to receive in a similar manner the outer polygon. This having been fixed in place, and the two polygons connected by the radiators, the outer piles were raised. The caisson plates were set up, being first bolted together, and then partially riveted. The whole of these operations occupied seven days and a quarter, the staff employed consisting of four workmen, and parties of from six to eight men from the crew. The lighter Ushruffee was then moored upon the reef, and the steamer proceeded to whence it returned with 50 tons of cement and twenty Arab labourers, under a native foreman, for depositing the concrete, and having a second lighter in tow. The concrete here used consisted of three and a-half measures of coral sand to one measure of cement. The first operation was to fill up the holes between the coral lumps with coal bags filled with concrete, so as to make an even surface to lay the tarpaulins upon. The deposit was then carried on in the same manner as at the Ushruffee. The quantity of cement, above alluded to, was only sufficient to complete three-fourths of the required height of the block. This occupied just eight days, and then the author returned to Ushruffee, and finding five tiers of that lighthouse erected and partly riveted, he handed over the entire charge of both works to Mr. Scott, who shortly after proceeded with a party of four mechanics, two riveters, four labourers, and ten Arabs, in all twenty, besides the crew, to the Dœdalus. With these, in twenty-six days, the work being carried on only on twenty-one days, the whole framework was erected and riveted together, two floors and the water-tank were completed, and the lower room was enclosed.

Two mechanics and four seamen were then placed in the building, with provisions and water, to continue the work, and the *Union*, with Mr. Scott and the remainder of the working party, returned to Ushruffee. Thus in thirty-seven working days, the main portion of the building, now 57ft. in height, was so far finished as to be habitable for a party sufficient to complete the remaining details. Had the ship been of larger burthen, it was believed that these thirty-seven days might have been continuous, and that the whole would have been accomplished during an absence of about seven weeks from Suez. The author referred in terms of the highest praise to the manner in which what might be termed the nautical part of the undertaking had been carried out by Captain Kirton. Subsequently the materials for the lantern and the lighting apparatus were deposited in the building, and afterwards one leading mechanic, two labourers, and five seamen, completed the work between November, 1862, and the 1st of February, 1863, when the light was exhibited.

At the last mention of the Ushruffee the concrete base had been completed, and five out of eleven tiers of framing had been erected. During the absence of Mr. Scott and his party at the Dœdalus, a European boat's crew of six men was engaged in conveying the remainder of the materials to the reef, and in sorting them there. On the return of the working party the erection was rapidly proceeded with, in the face of much difficulty from almost constant high northerly winds. The time actually taken in erecting the skeleton frame work, 106ft. in height, was two months, and the riveting was completed within three months. The two succeeding months were occupied with the erection of the lantern and lighting apparatus, and completing the details of the building, and on the 1st of July, 1862, the light was first exhibited.

In connection with this undertaking the profession had to regret the loss of a very promising young member, Mr. C. W. Scott, who towards the close of the operations was attacked with symptoms, which developed the seeds of a disease of long standing, under which he succumbed after an interval of five months.

With regard to the cost, a mere statement of the total amount expended upon the two lighthouses, £55,211 in all, would convey an erroneous impression, unless accompanied by an explanation. The cost of the whole as an engineering work, independently of the employment of the steamer, might be taken at £32,079, including all contingencies, supposing the reefs to have been within a boating distance, say one mile and a half and half a mile from Suez. If the steamer had been equipped at Suez, and had been continuously employed, then, on this supposition, the cost might have been £42,082. The remaining expenditure, £13,029, was entirely exceptional, arising mainly from the steamer being equipped at Bombay.

ON THE DUTY OF THE CORNISH PUMPING ENGINES.

By Mr. W. Morshead, Jun.

It appeared from a tabular statement prepared by the proprictor of "Lean's Engine Reporter," for the years 1841 to 1860 inclusive, that the average duty of these engines had fallen off from 68 millions in 1844 to 52 millions in 1860, or 25 per cent.; also that less interest was now felt in the performance of these engines, as while fifty were reported in 1841, only fifteen were reported in 1858 and twenty-five in 1860. Although the nominal, or reported duty showed this marked diminution, it was not asserted that there had been an actual falling off to the extent thus indicated;—for the duty paper did not take into account the quality of the coal, which was certainly inferior to that used twenty years ago; besides which the present practice of sinking the engine shaft, for the whole, or part of its depth, in an inclined direction upon the course of the lode, must have tended to increase the friction of the pitwork, and the mines were also deeper than formerly. Nor was expansion of steam adopted to so great an extent now as it was some years ago; it was then carried further than was compatible with safety, as was evidenced by the repeated breakages of the main rod, the piston rod, and the other principal parts of the engine. But after allowing for all these legitimate causes of the falling off of duty, it was thought that the average duty of the county was still at least ten millions below what it should be.

The Author next examined the causes of this decline, and then discussed the means by which it might be remedied. The primary cause he believed to be, the indifference of the mine proprietors to the performances of the engines. So many accidents attended the use of high steam, cut off at an early part of the stroke, that economy of fuel came to be regarded as synonymous with repeated breakages; but it was quite possible to raise the duty considerably above the present average, without resorting to an undue rate of expansion. This might be accomplished by a more perfect and extended system of reporting the engines, and by a new form of duty paper, embracing the following additional items:—First, that the load upon the piston should be taken from an indicator diagram, and from the load thus ascertained the duty should be computed, the difference between the load upon the piston and the weight of water actually lifted, that was the loss by the friction of the pitwork, &c., being placed in a separate column. Secondly, that the part of the stroke at which the steam was cut off, as well as the vacuum obtained, should be stated opposite each engine. Thirdly, that a notice of the quality of the coal used, as far as it could be ascertained, should be added. And lastly, that the engines should be separated into two classes, those which might reasonably be expected to give a good duty, and those which, from the time they had been at work, their small size, or other causes, could not fairly compete with the former. By taking the load upon the piston from an indicator diagram, a fair estimate of the work actually done by the engine could be formed, while by placing the difference between the load upon the piston and the weight of water actually lifted in a separate column, encouragement was offered for improvement in the construction and fixing of the pitwork.

At present, only about one-tenth of the engines at work in Devon and Cornwall appeared in the monthly reports. If mine proprietors would co-operate in supporting a good form of duty paper, there was little doubt but that there would be a rapid and marked improvement in the duty of the Cornish engines.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.

Mr. John Ives in the Chair.

At the ordinary monthly meeting of the above society, on the 6th ult., Mr. Oubridge read a paper on "A Method of Casting Guns Hollow, and Cooling them from the Inside by a Current of Air."

The reader remarked that the subject which he proposed to consider that evening was one upon which much had been already said and written. He believed, nevertheless, that it was not exhausted, for it was a fact that, as yet, no heavy gun had been produced which answered all requirements. Brass guns had had their day, cast iron guns had been long used, were at one period almost totally condemned, but were now cropping up again, and much might be adduced in their favour. Wrought iron, in multifarious forms, had been employed in the manufacture of guns, each form having peculiar advantages; but the results, on the whole, were not satisfactory. Steel has also been introduced for the purpose; but in spite of its great cohesive strength, it had been found impossible hitherto to make from it good, sound, and serviceable guns of large calibre. Many practical difficulties stood in the way of its employment in this direction, although certainly some very successful efforts had been made to construct light and small pieces of ordnance of that material. Compound guns, composed of cast and wrought iron—the one encasing the other—had also been tried, with variable and uncertain effects; but as yet no absolute rule had been deduced for the guidance of those whose duty it was to manufacture heavy guns. Time, and the expenditure of much more of the public money, might effect this great desideratum, but it had not yet been achieved, and it was, therefore, the duty of practical and scientific men to endeavour to solve the problem "how best to manufacture heavy guns?" He intended to contribute a few items to the mass of existing information on the subject, and he might state that such knowledge as he had to impart had been gained from his own experience and experiments in the iron foundry. It was required in the production of large pieces of ordnance that the material used should be made to offer the fullest possible resistance to the bursting strain to which it would eventually be exposed, and that the cohesive strength of that material should be completely maintained. Perhaps, before advancing his own views, he might be permitted to refer to the method of casting heavy guns, which had been largely practised during the unhappy contest which still raged in America. The name of Dahlgren would no doubt be familiar to his hearers in connection with the American civil war, and the guns which were known as "Dahlgren's" possessed some distinguishing features. They were cast hollow, the theory of their inventor being that it was desirable "to reduce the neutral axis of his gun as nearly as possible to the centre of the thickness of the metal of which it was formed." If, on the contrary, the gun was cast solid, the cohesive power of the metal would be diminished as it approached the centre. By casting the gun hollow, this deteriorating process would be lessened by the pressure of the core in the mould. Dahlgren had evidently well considered the laws of cohesion and disintegration which governed these results. He had also adopted the plan of assisting the cooling and contracting, by pouring a stream of cold air through a tube of iron inserted in the core barrel. In this he was perfectly right, for it ought to be understood that if the cooling process operated entirely from the outer portion of the casting it was, to use a familiar illustration, like casting an iron ring upon a maudril—an operation which they all knew would be a senseless proceeding. This plan had, however, been persistently followed until the Armstrong gun was introduced. He (Mr. Oubridge), had, several years before, submitted to the select committee of the Board of Ordnance a scheme for casting heavy guns hollow, but the reply of that body was, as usual in such cases, unsatisfactory. At the same period an American gentleman made some attempts to accomplish, in this country, the same thing, but without success. For his purpose six cupolas were erected near to the Charlton Pier, on this side of the town of Woolwich, and the experiments there conducted were of a costly character. The theory was not the less a true one—the defect lay in its imperfect realisation.

Mr. Oubridge stated he had no doubt in his own mind that homogeneity would be obtained to a far higher degree in large iron castings if they were made hollow in place of being solid. He had had an opportunity a few months back of demonstrating the fact. A large hydraulic cylinder, requiring seventeen tons of metal to cast it, had to be produced. It was to have a very small hole through the bottom end, where the iron would be 15in. thick. He saw that the intense heat would inevitably melt the core barrel long before the metal composing the cylinder ceased to be fluid. He therefore assumed it to be a favourable opportunity for putting to the test his cherished theory, and Messrs. Simpson, of Pimlico, and he, determined to cool the core of the casting produced at their foundry, by means of an internal current of cold air. The plan of operation was very simple. A perforated tube was inserted in the core barrel, and then communicated, by means of a pipe and valve, with the blast. As soon as the mould was filled with metal the valve was opened, and the cold air forced into the tube found an outlet through the perforations when it impinged upon the barrel. This latter was also perforated so as to allow of the escape of gases from the interior of the core. The result was a complete success, and the cylinder was as sound and homogeneous as could be desired. The cooling process had thus gone on from the centre, instead of the exterior of the casting. When he had considered that the operation had lasted sufficiently long to prevent the metal remaining in a fluid state, he caused the blast valve to be shut, and in half an hour the core barrel was found to have melted in one place, leaving an aperture 3in. in diameter. The blast was then again turned on, and in less than ten minutes the barrel became black, By this method, which was of the most easy application, it was possible to reduce the temperature of the interior of a casting to almost any extent, and in a very short space of time. Mr. Oubridge's paper was listened to with attention, and was well illustrated by diagrams.

THE WRECK REGISTER AND CHART FOR 1863.

The following is a synopsis of the returns made by the Board of Trade to Parliament, of the wrecks and casualties which have taken place on the coasts, and in the seas, of the British Isles during the past year.

It may here be observed that the materials from which these valuable documents are compiled are derived from reports furnished by the Officers of Coast Guard, and Receivers of Wreck, resident on the shores of the United Kingdom.

When we remember that the number of vessels which entered inwards and cleared outwards from different English ports in the course of the past year was 268,462, and that these ships had on board, probably, 1,610,000 men, it becomes almost a matter of certainty that a large number of casualties should take place amongst them every year.

The coasts of the British Isles extend upwards of 5000 miles, and on looking at the wreck charts which accompany the register, it is observed that there are few parts of that continuous shore which are not studded with the usual wreck marks; and thus it is that on nearly every page of the register this startling fact constantly presents itself—that during the year no less than 1827 wrecks and casualties took place on our coasts, with the loss of 690 lives.

Compared with previous years the register informs us that the wreck experience of the past year is very unfavourable. But the number of lives lost is fortunately considerably under the average, owing chiefly to the valuable and prompt services of lifeboats and other means employed on occasions of wrecks on our coast. The wrecks and casualties in the year show a large increase on the average of those during the preceding eleven years. The number of wrecks in the last eleven years was 13,657, while the total voyages made to and from the British ports in that period were 2,745,910—so that 1 ship was wrecked out of 201. During the past year. as previously stated, the number of voyages of vessels to and from ports in the United Kingdom was 268,462, and out of this large number 1827 casualties occurred—or 1 in every 147.

In the past eleven years, from the above wrecks 8775 persons were lost, or nearly 800 each year. Last year, it appears from the returns that the lives of 4729 persons were imperilled on the coasts of the British Isles, of which number 690, or 14·59 per cent. were lost. The wrecks and disasters for the year 1862 may be thus classed:—

	Vessels.
Totally wrecked	455
Seriously damaged	695
Totally lost in collision	66
Damaged seriously by collision	272
Injured by collision	339
Total	1827

This number of disasters for last year is at the rate of five per day.

The months of January, February, March, October, November, and December were the most destructive to ships.

The startling facts which the Wreck Register discloses each successive year have succeeded in drawing general public attention to this important subject, and it is frequently referred to in Parliament. On a recent occasion, when Lord Ravensworth alluded, in the House of Lords, to the necessity of constructing harbours of refuge on the north-east coast, he caused to be suspended in their Lordship's library a large wreck chart lent by the National Lifeboat Institution.

The fearful scenes represented on that chart naturally excited their Lordships' attention. Indeed the dreadful havoc which storms commit every year in the seas and on the shores of the British Isles can only be fully realised by the aid of such a chart.

It is, however, satisfactory to find that the publication of the "Annual Wreck Register" of the Board of Trade, and other means of publicity, have materially contributed to the establishment on our coasts of a system of life-boats and life-preserving apparatus, which reflects the greatest credit on the philanthropy of the age in which we live, and on the energy with which these means have been placed on our shores, by the joint action of the National Life-boat Institution and the Board of Trade.

Amidst the desolating scenes which the Wreck Register and Chart reveal, it is consolatory to know that by means of life-boats, the life-preserving apparatus, ships' own boats, and other means, 20,158 lives have been saved from a watery grave during the past seven years, of which 4039 were rescued last year.

The following is a summary of the means used in saving the 4039 lives from wrecks on the coasts of the United Kingdom during the past year:—

By life-boats and rocket and mortar apparatus	637
By ships, ships' own boats, shore boats, steamers &c.	3389
By individual exertion	13
Total	4039

As usual, ships, ships' boats, and smacks have saved more lives in that period than the life-boats and the rocket and mortar apparatus. This apparent discrepancy is susceptible of easy explanation. When a disaster takes place in British waters, it frequently happens that either a ship or smack is fortunately at hand to render assistance to the crews of the distressed vessels. Such help is seldom attended with any very great danger (although sometimes it is so), and the men are often brought ashore before any tidings at all have reached a life-boat station. But the great value of the services rendered by life-boats can only be appreciated by considering that they are mostly performed on occasions when no other craft could be launched from the shore with safety.

Schooners and brigs were, as usual, the most numerous description of vessels that were lost during the past year on our shores. These are usually employed in our coasting and coal trade, and the destruction of hundreds of them even in moderate gales is now reduced to a matter of certainty.

In December last seven vessels foundered off the east coast of England —with the loss of all hands—while engaged in coasting voyages. One of them was a collier sloop 71 years of age! Another collier brig also foundered in October last, and 7 out of 9 of her crew were drowned. She was 99 years old!

The following is an analysis of the tonnage of the ships lost last year:—

	Vessels.
Vessels under 50 tons	341
51 and under 100 „	441
101 „ 300 „	784
301 „ 600 „	186
601 „ 900 „	44
901 „ 1200 „	20
1201 and upwards „	11
Total	1827

The most destructive gales of wind were those that blew from S.W., S.S.W., W.S.W., and N.W.

We find that the ages of some of the vessels that were hurried out of existenee were as follows:—

Under three years	122
3 and not exceeding 7 years	271
8 „ „ 10 „	131
11 „ „ 14 „	155
15 „ „ 20 „	216
21 „ „ 30 „	266
31 „ „ 40 „	125
41 „ „ 50 „	59
51 „ „ 60 „	25
61 „ „ 90 „	14
91 „ „ 100 „	1
Unknown	442
Total	1827

We also remark that, in perfectly calm weather, 23 vessels were wrecked; in light airs, 28; in light breezes, 56; in gentle breezes, 43; in moderate breezes, 110; in fresh breezes, 187; in strong breezes, 195; in moderate gales, 75; in fresh gales, 170; in strong gales, 199; in whole gales, 218; in storms, 63; in hurricanes, 69; and in unknown and variable weather, 52.

We, moreover, observe that 321 vessels were wrecked that were under the command of masters holding certificates of competency; while 720 were wrecked that were commanded by others who were not required by law to hold such certificates; and 266 that were commanded by foreigners not having British certificates.

We observe that of the total wrecks during the past year on our shores, irrespective of collisions, 60 vessels foundered; 41 vessels were driven or run on a lee shore; 66 parted their cables, or dragged their anchors and went on shore; 40 were wrecked from damage to hull, or the loss of masts, yard, or sails; 3 were actually capsized; 72 were wrecked from inattention, carelessness, or neglect; 25 from defects in ships or equipments; 7 from a combination of causes, while 18 arose from accident.

Of the total wrecks that took place from collisions, 18 were from bad look-out; 22 because the rule of road at sea was not observed; 1 from the want of sea-room; 4 in thick and foggy weather; and 4 from neglecting to show lights; but it is worth observing that only 1 collision with total loss occurred from the error of the pilot who was on board; 4 occurred from negligence and want of caution.

It is also a lamentable fact, in regard to collisions, that 141 took place in fine and clear weather; the whole number of collisions during the year being 338—102 in the day time and 236 in the night. Last year 11

collisions occurred between the steamers, and 190 between sailing-vessels, while both were under way. 32 collisions also took place between sailing-vessels, one being at anchor and the other under way at the time; but no collisions occurred between steamers under these circumstances. 46 collisious likewise took place between steamers and sailing-vessels, both being under way; and 6 only when sailing-vessels at anchor were run into by steamers. 53 collisions also occurred by vessels breaking from their anchors or moorings. We earnestly trust that the admirable regulations which the Board of Trade have just published to prevent collisions at sea will materially tend to lessen the number of these fearful disasters.

The most disastrous wrecks, with the greatest loss of life, occur between that part of the coast extending from Skerries and Lambay to Fair Head and Mull of Kantyre. During the past thirteen years 1641 lives were lost in that district. The next is from the North Foreland to St. Katherine's Point, which during the same period claims 1136 lives.

The estimated loss of property involved in the destruction of a portion only of the vessels wrecked in the last six years amounted to four and a half millions of pounds sterling, although the total amount, being unreported, cannot be ascertained; but who can appreciate the value of the precious lives lost in those terrible disasters, except those at our seaports and fishing villages who are now widows and orphans or friendless, who have bewailed with unutterable anguish the loss of a husband, father, or near relation?

On the other hand it is most gratifying to find that in these six years 4169 lives were rescued from the jaws of death by life-boats and the life-saving apparatus *alone*. It may be proper to observe that these means of saving life are rarely used except under the most perilous circumstauces.

One can hardly conceive a more pitiable sight than a noble ship stranded on a sandbank during a gale of wind, with her crew in the rigging, or firing minute-guns as signals of distress, so that they may obtain help from the shore. On observing these signals the crew of the lifeboat immediately put off. Indeed we know of no spectacle more sublime, or more calculated to send the blood thrilling through the veins with admiration and awe than the cool, determined courage and the lively charity that sends these poor and often half-starved fisher fellows out in the dark night, in the midst of bitter frost and snow, into a tumultuous sea and surf, hungry for their bodies, in the very teeth of a furious wind with death threatening them on all sides, and nothing but their coolness and skill to rely upon to preserve their own lives, to say nothing of the lives of others—leaving wives and families of little ones at home who may never see them in life again. What stout hearts those must be as, yard by yard, they struggle away from the dim shore, lost in an obscurity of scud and surf, and snow, thinking of nothing but their duty—the errand of mercy and charity before them—through the raging tempest—winning their way through seas that to the landsman are fearful to gaze on, even from the safe standing on the beach, momentarily threaten to overwhelm them! Out further and further yet into the dark void a speck on the waters. Another flash of the minute-gun points out where the vessel is lying aground upon a shoal, the sea making a clean breach over her, and the scud and spray flying sheer over her mastheads, which threaten to go every moment. Stand to it, stout hearts! a few more minutes of the heavy toil and the boat will be well in to leeward of the wreck, when the most dangerous part of the whole operation will commence; for there is danger of her being stove in momentarily, either by contact with the wreck itself, or with the floating spars which may be hanging loosely around her. The relief of a wreck is no mere child's play—it often occupies hours of hard, dangerous, and unremitting toil. It is no mere sudden flash of generosity that is required—no enthusiasm burnt out as soon as kindled; but that steady, undaunted "pluck" which distinguishes frequently the highest as well as the lowest class of Englishmen in times of danger. How important then is the work of the National Lifeboat Institution in providing these messengers of mercy on our coasts, and in encouraging noble deeds of daring in the rescue of our fellow-creatures from an awful death.

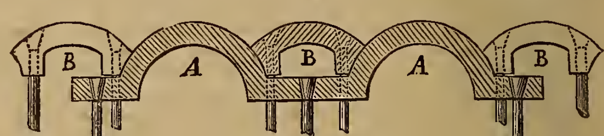
It may be interesting here to recapitulate briefly the operations of the National Life-boat Institution, which has now 125 life-boats under its management. During the past year, in addition to saving twenty-one vessels from destruction, 358 lives were rescued by the life-boats of the society. For these services rewards amounting to £915 18*s.* 6*d.* were voted. The number of lives saved by the life-boats of the society, or by special exertions, for which it has granted rewards since its formation, is 13,220. For these services 82 gold medals, 733 silver medals, and £17,220 in cash have been granted as rewards. The institution has also expended £75,380 on life-boats, life-boat transporting carriages, and boat-houses. Surely a society which has thus been productive of the greatest services in the cause of humanity, will not have to appeal in vain to the public for help to enable it to continue its merciful work on our dangerous sea-board! We may add that contributions in aid of the great and important work of the National Life-boat Institution are received by all the bankers throughout the United Kingdom, and by the Secretary at the Institution, 11, John-street, Adelphi, London.

CLAPP AND COATS' IMPROVED ARMOUR PLATES, &c.

One of the most recent plans proposed for armouring vessels, turrets, forts, &c., is that jointly invented and patented by Messrs. Clapp and Coats. As shown in the accompanying woodcuts, it will be seen that the inventors purpose using plates of iron or other suitable metal with curved and with flat portions, and through the flat portions pass bolts or rivets to secure the same to the framing of the vessel, turret, target, fort, or structure, in such manner that other curved plates may be placed over the flat portions of the first-mentioned plates and over the joints thereof, to cover and protect such bolts or rivets first-mentioned, the last-mentioned curved plates being bolted or riveted through the first-mentioned curved plates or otherwise, or secured in any equivalent manner, by which means additional strength is obtained and the principal (and, if desired, the major part of) the joints and bolts or rivet heads are protected, so that a single plate shall not receive all the force of any projectile or striking body, but such force be distributed over the whole of the plates, thereby rendering them impregnable if constructed of proper thickness. It is preferred that the plates should be produced by rolling or compressing.

Fig. 1 is a plan view showing how the main plates and completing plates are put together; fig. 2 is a section on the line *a b*, showing com-

FIG. 2.



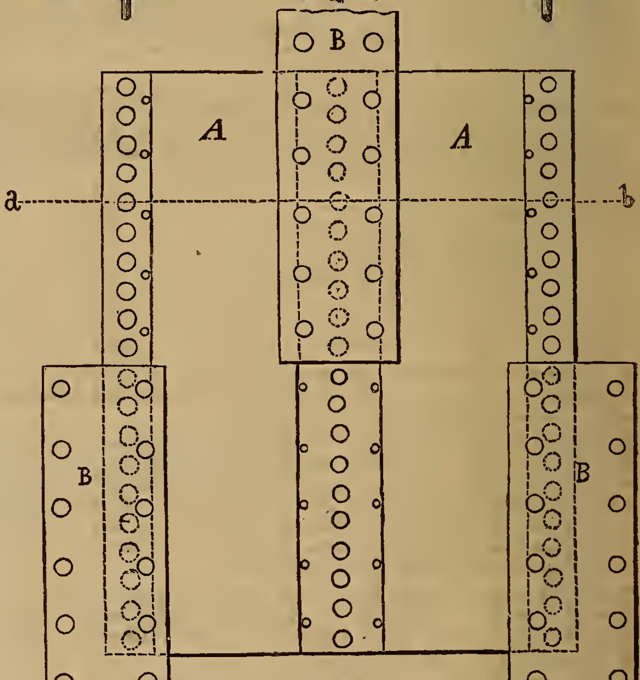


FIG. 1.

pleting plates bolted through from outside; fig. 3 is a section of an arrangement in which a long perforated plate or tongue is fitted in the top of a whole line of the bolts which pass through the main plate, and which plate

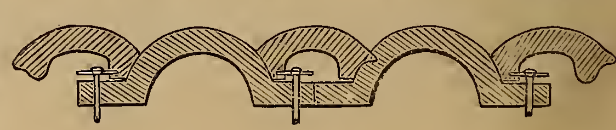


FIG. 3.

or tongue takes into a groove. The completing plates may also be secured by an eye-bolt passing through the main plate; a smaller cross bolt or rivet passing through the eye of the said eye-bolt, and fitting into a groove inside the completing plate; or, as a modification of this arrange-

ment, the cross bolt may have an eye, and is fixed on top of the principal bolt. Fig. 4 is a part section of vessel with plates fitted to the side; fig. 5 is an exterior view of part of a ship or vessel with plates fitted.

In the accompanying figures A denotes the main plates, which are bolted to the framing of the vessel, as shown in fig. 1, and then the completing plates B are slidden in between them (as in fig. 1 showing this partly effected). The completing plates if to be bolted or riveted through from the outside, to have the bolt or rivet holes brought over the holes in the main plate.

The lengths of completing plates, when secured, to be firmly fastened at the ends of each line to prevent any sliding or shifting, as, for instance, by bolting the said completing plates firmly through, as shown in fig. 2. The tongue plate should be made of rolled or compressed iron and the main plate with which it is used should have a sufficient number of bolt or rivet holes to receive the tongue plate, and thereby secure the completing plate to the main plate, and so that these bolts or rivets will pass through every alternate hole, the remaining holes to be used to secure the main plate to the framing.

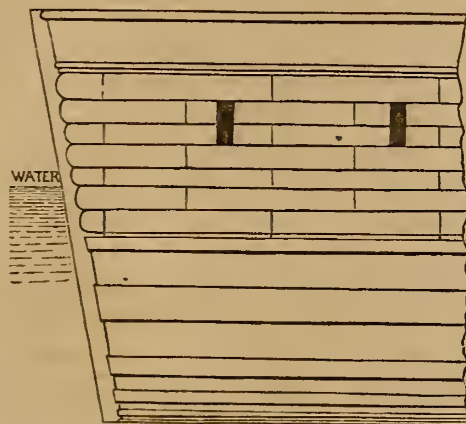


FIG. 5.

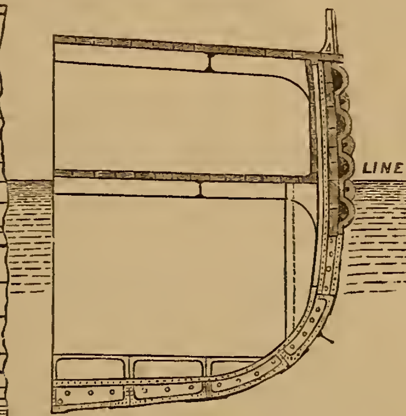


FIG. 4.

PREVENTION OF DECAY AND OXIDATION IN SHIPS.

As the prevention of decay in the timbers of wooden-built ships, and the fouling and oxidation of the plates of iron ships, have received considerable attention from the Admiralty and Merchant Shipowners, the following *resumé* of all the specifications at the Patent-office bearing on this subject is given:—

Dipping timber in boiled oil is a very ancient practice, and it would be difficult to trace its origin. In 1739, Alexander Emerton took out the first recorded patent for preserving wood from decay. He prepared the planks or boards with boiling oil in the then old way, and afterwards coated them with compounded poisons, powdered glass, and sand, cemented with painting colours and oils, laid on as paint. The next patent, which was for preserving copper, or plates of which copper is a basis, was granted in 1790 to Collins and Wyatt. They covered the plates with lead or tin. In the early part of the present century several chemists recommended decoctions, in the form of vegetable poisons, for saturating timber, and thus destroying all animal life in the green wood. None of these poisonous solutions seem to have succeeded, for, had they been found efficacious, their application would have been continued. There was then an interval, during which the stoppage of decay seems to have been abandoned, and dry rot allowed to take its course. In 1822, John Oxford secured a patent, whereby he undertook to prevent oxidation or decay in iron or wood, by preparing tar in such a manner as to stop the evaporation of the oil contained therein, saturating it also with chlorine gas. This purified oil is then mixed with 100 parts of white lead—or of the red oxide—25 parts of carbonate of lime, and 25 parts of purified coal tar added to the oil of tar. These ingredients are then applied as a paint. In the first days of iron in shipbuilding, rust was found to be a drawback to its general introduction. Scientific men saw the disadvantage, and sought to remedy the effect. Galvanic action, it was considered, would set all right, and the earliest patent in this direction was taken out by G. G. Bompass, in 1830. He sought to preserve metals from corrosion by an electric or galvanic process. For copper to be protected in sea water, he attaches an alloy of 9 to 10 parts of zinc with 100 parts of copper. In protecting iron he employed an alloy of tin, consisting of from 10 to 150 parts of tin combined with one of zinc. Following in the footsteps of Mr. Bompass, in the same year, Mr. John Revere patented an invention for fixing zinc protectors to the brace or stud of chain cables, and other iron surfaces exposed to the action of salt water. These galvanic zinc protectors were riveted or soldered on according to requirement. It is known that one of the most distinguished of our electricians is in favour of inserting strips of zinc in the plates of ships; but if this principle proved correct in practice, it would long since have been universally adopted. Zinc plays an important part in patents for the prevention of oxidation. In 1837, Jacob Perkins got protection for a plan of coating copper tubes of boilers with a preparation consisting of two-thirds of zinc with one-third of copper; but he had been preceded in 1832 by Captain H. W. Craufurd, R.N., who proposed to preserve copper and iron from oxidation by coating with zinc paint in a fused state. Over this he laid a second covering of pure tin, or tin alloyed with lead. Captain Craufurd explains in detail his method of compounding the ingredients. In 1838, Le Comte de Fontainemoreau, considering Captain Craufurd's mode of fixing or adapting the zinc to this purpose as erroneous, applied for a patent of a more comprehensive description, for applying the zinc coating to metals. Again, in 1839, Mr. Thomas Dowling patented what he terms a conservative bath, applied to metals after grinding. He describes the machinery by which he effects this, the chief of which is a zinc wheel and galvanic vapour furnace.

In 1840, Mr. J. R. Neilson came forward with his invention for the application of a coating of copper, or copper alloyed with zinc or tin, or both, to the surface of iron. This was done by covering the mould to be cast with the material. In malleable iron, dried boraux or flux is spread over the iron, which is then prepared with alloy heated to a temperature sufficient to melt copper, and, in its heated state, plunged into cold water to detach the scale of oxide. Mr. Arthur Wall, likewise in 1840, mixed 20lbs. of the strongest muriatic acid diluted with three gallons of water, then added 12lbs. of steel or wrought-iron filings. The filings were heated to redness before mixture. The whole was then subjected to heating in a pan, &c., and the composition was then applied to prevent corrosion. In 1841, Mr. W. E. Newton employed silicates of potash, or soda, for making a plaster or coating to prevent iron from becoming rusty. After him came Professor Mallet, engineer, of Dublin, whose varied processes are of the most complex character. Finding that iron covered with zinc, when immersed in sea water, and certain fresh waters, gathered to itself a coating of carbonate of lime, destructive to the protective power of the zinc, and affording a surface for the attachment and growth of marine animals of the molluscous and testaceous classes, and aquatic plants, he applied chemical means to detach the scales of oxide from iron, and then plunged it into a preparing bath. After undergoing a series of processes the metal is coated with an alloy or zoofugous paint, which paint is rendered poisonous by admixture of salts of metals, by means of which h sought to render the zinc effective, as an anti-corrosive protector. In 1841, also, Mr. E. Morewood endeavoured to preserve iron from oxidation or rust by tinning it, and then dipping the tin covering or surface in molten zinc. Mr. Moses Poole, in 1845, claimed to possess an invention whereby he rendered iron more hard and durable, and free from oxidation, by the use of ferrocyanide of sodium, calcium, barium, or any other alkali, or alkaline earthy base; to be used in a manner fully set forth in his specification.

* "Journal of the Society of Arts."

In 1846, Mr. Andrew Smith improved upon the plans for melting the zinc. He employed a bath of lead or tin, or any composition or medium that melts at a lower degree of heat than zinc, by which means the heat from the fire of the furnace is taken up and transmitted to the receptacle containing the zinc for melting. Baron Wetterstedt, in 1846, added the regulus of antimony to lead sheets, combined copper with antimony, made sheet metal by using lead and tin, and lastly, protected metals by paints thus prepared:—1st. One part of regulus of antimony to three parts of copper, mixed, melted together, run out into water, and then heated gently. Two parts of oxide of copper are added, and moistened with naphtha. The whole is then added to a composition of tar and naphtha. 2nd. Another paint is compounded of 3lbs. of tar, 30lbs. of pitch, 20lbs. of dried soot, 4lbs. of tallow from sperm oil, and naphtha added for consistency.

Mr. C. H. Paris, in 1849, coated metals with glass or vitreous matter. The metal went through a cleansing process. Gum water is then applied, and over this the dry or powered glass is shaken, and then fused by heat till a glass surface is formed. Mr. Paris claimed the application of carbonate of soda for applying glass in this manner. Mr. J. Mactintosh, in 1852, made a paint from decomposed india-rubber, in combination with oils or fatty matters, saponified by metallic salts, with lime for thickening the liquid. For bottoms of ships he recommends the india-rubber, when in a fluid state, to be combined with metallic soap, thickened with lime and coloured by pigments. Messrs. Hughes and Firmin, in 1852, manufactured lamp black from the vapour of coal tar, dead oil, dead oil salts, coal pitch, naphtha, linseed oil, and other materials. From the products a fuel is produced, and this residue has by another inventor been mixed with oils, ground, and made into a paint. In 1852, also, Mr. R. M. Glover took out a patent for a preparation of arsenite of lead and arsenite of copper, and the red and yellow sulphurets of arsenic. The proportion of each were as follows:—Two parts, by weight, of arsenite of lead, one of realgar, one of orpiment, and one of arsenite of copper. In the same year, Mr. J. Murdoch invented a variety of driers for zinc when the white of zinc is employed instead of white lead. The protoxides are manganese, cobalt, iron, tin, and nickle; for acids the benzoic, urobenzoic, and the boric. In 1852, Mr. Binks patented a substitute for linseed or drying oils, in the products derived from dissolving what are called insoluble soaps. A pigment is then ground in this solution, and the paint is ready for application. The pigment may be white lead, oxide of zinc, lamp black, or any other. J. C. Medeiros, in 1853, proposed the use of mercury or quicksilver on iron plates for sheathing ships. The salts of mercury are dissolved, then a bath is formed, and the plates allowed to remain in the solution till their surface is equally and regularly amalgamated.

Mr. Newton, in 1854, made a paint from ground plumbago, pulverised charcoal, and the black soot formed by the burning of bituminous matter, along with ivory-black, or bone or lamp black. Mr. Ryder also, in 1854, described a method for mixing gutta percha with common resin, or tar, or pitch, or asphaltum, dissolving them in impure benzole or coal naptha. Mr. Newton took out a second patent, in 1854, for the production of a siccative black, brown, or grey pigment or colouring matter, by the admixture with the gas tar, or other organic substance to be carbonised for the purpose of the oxides of potassium, sodium, calcium, aluminium, or other alkaline or earthy pases for paints. Mr. F. Ransom, in 1854, patented a mixture, consisting of ground oxides and carbonates of lead or zinc, and carbonate or sulphate of barytes with soluble silica. Mr. J. Rogers, in 1855, to prevent oxidation, deoxidizes metallic ores by a revolving cylinder, fitted with helical or screw formed divisions to receive the ores in a pulverised state, and then submits the same to heat, and constant agitation by the revolution of the cylinder. Mr. B. Rosenburg, in 1855 manufactured a paint as follows:—100lbs. of triturated white lead, $2\frac{1}{4}$ gallons of copal varnish, $1\frac{1}{8}$ gallons of spirits of turpentine, $1\frac{1}{8}$ gallons of linseed oil, and for colouring, a small quantity of red lead. Before the metal is painted it is subjected to the fire for cleansing, and when cool the preparation is applied, then varnished with copal, and dried by a hot air process. Mr. J. E. Cook, in 1855, proposed a composition consisting of gum shellac, dissolved in methylated spirit or in wood spirit. In 1856, the patent of Messrs. Bancroft and White claims the manufacture of oils from petroleum, for preserving metals and ships sheathing. Mr. A. F. Mennons, in 1856, obtained a patent for a non-conducting and inoxidable composition for metals, made thus:—

Argillaceous clays, containing a certain proportion of alumina	100	parts
Oily substances and residues	6	„
Oil sediment...	5	„
Fat	2	„
Animal charcoal	2	„
Mucilaginous substances, such as glue, &c	2	„
Wood sawdust, already employed in the purification of oils in the process of dyeing	10	„
Waste hair well beaten	4	„

To the preceding materials a decoction of logwood and soot is then added.

Mr. J. M'Ines, in 1856, was granted a patent for coating metals with powdered emery stone mixed with a varnish of shellac dissolved in spirits of wine, with the addition of castor-oil. As emery contains 87 per cent. of aluminium, Mr. M'Innes considered that this paint would be solid enough to resist all action in the water, and never decompose. Mr. R. D. Atkinson, of Hull, in 1856, invented a plan for coating and protecting metals from oxidation, by depositing copper or brass upon surfaces of prepared iron, the deposit to be melted in conjunction with carbonic acid gas, the coating to be put on by a brush, or through the medium of galvanism. Depositing brass on iron is now being successfully carried out at Portsmouth, by Mr. Wielan, on armour plates and other iron surfaces. Mr. A. Reid, mineralogist, in 1856, describes in his specification what he deems a sure way of preventing oxidation. He places the iron in a properly constructed furnace, then covers the metal with soot, or other matters possessing the like element; the temperature is then raised to red or white heat, and continued for half an hour, or according to the size of the iron operated upon. It is then suffered to cool, the surface is cleaned, and Mr. Reid asserts that a coat impervious to rust is formed. If this is verified by positive experiments, the cheapness and simplicity of the plan deserve to be widely known. Mr. Joseph Poleux, of New York, communicates, in the same year, a plan to overcome oxidation. He employs muriatic acid, nitric, or sulphine acid, of the ordinary degrees of concentration in commerce, without dilution, combined with the introduction of spelter into the cleansing process. In 1857 Mr. G. Bedson patented a new process. He melts a quantity of pitch derived from mineral tar, and a proportion of tar oil, with caoutchouc tempered with tar oil and shelllac, the substance to be solid and elastic when cold. Mr. C. F. L. Oudry claims depositing copper on a preservative or intermediate coating instead of on the metal. He deposits copper in a pure state to any thickness on all metals. Mr. C. Iles, in 1857, described a means of applying earthy cements to metals. In 1858, Mr. J. Coutts received a patent for applying the following pigment by heated air:—

Carbonate of baryta	·650
Litharge...	·065
Arsenious acid	·030
Asphaltum	·050
Oxide of calcium...	·030
Creosote (oil of tar)	·175

Perhaps the most novel introduction is that patented here by Messrs. Bouchard and Clavel, the Paris bankers, in 1858. On the estate of La Gruerie, in Charney, Department of Yonne, France, is found an earth of the ochre description, called "Burgundy Red." This earth contains most valuable properties, and is said to be an exceedingly good preservative against rust. It is used as a cement and paint by admixture with the following:—

Burgundy red	66	parts
Grease or oil...	15	„
Lime...	11	„
Unburnt earthenware, chalk, or Roman cement	8	„
	100	„

This is said to prevent oxidation if the earth is merely diluted with volatile oil. D. M'Crae, in 1858, was allowed a patent for preserving bottoms of ships from fouling or decay. He applies grease from the cells of boiled bones, kitchen-stuff, and butter without salt; a poisonous matter is mixed with these fatty substances. Mr. G. P. Lock, in 1858, made a composition for the under coating of iron ships, made from iron ore ground in boiled linseed oil 50 per cent., and oil of turpentine 50 per cent., well mixed. For the outer coatings, white lead 40 per cent., blue mineral or copperas 10 per cent., and oil of turpentine 50 per cent. In 1859, Mr. Henry, on the part of Moisant and Co., sought protection for bituminous products and compounds of bitumen for preventing oxidation. Mr. T. J. Labelle made a preparation of caoutchouc paints and colours for vulcanising. Mr. J. Crawford, of Liverpool, in 1859, applied for a patent for a metallic paint or varnish, composed of plumbago, or black lead, fine or gum varnish, arsenic, and spirits of turpentine mixed. Mr. F. W. Emerson, in 1859, prepared an anti-corrosive paint from oxi-chloride of lead, mixed and ground with oil, turpentine, varnish, or other vehicle. Mr. Weild, in 1859, sought to economise time and labour by a mechanical machine for applying paints to metals on large surfaces. Mr. James Meikle, in 1859, proposed coating iron ships with asphalte. In the same year, M. Auguste Pin dissolved sugar in muriate of zinc, then added wax and soap, in which was incorporated calcareous stones, phosphate of soda, sulphate of zinc, and copper, and the syrup of potatoes or sugar, with powdered marble, quartz, or felspar.

In 1859, Mr. F. G. Spilsbury, of Louvain, applied for a patent for the

manufacture of a paint. He took sulphate of lead, and heated it to a red heat, either by itself or mixed with alumina or other earths; the pigment thus obtained to be washed first with sulphuric acid, then with water, when it is finally dried. Previous to drying the pigments they are digested with salts of tungstic acid, molybdic acid, titanic acid, tantalic acid, arsenic acid, acid of antimony, or other metallic acid, or with mixture of the above salts. A combination between the sulphate of lead and the metallic acid or acids is obtained, and the resulting pigments are dried in like manner after having been cleared from all adhering salts. The pigments may then be mixed with oil and used as a substitute for white lead. Mr. J. F. F. Lecocq, in 1860, prepared a calcareous varnish for coating iron and the bottoms of ships. Mr. H. Kemp, in 1860, patented a composition consisting of peat tar, wood tar, methylated spirit, peat oil, or linseed oil, arsenic, resin and carburet of iron, for preserving ships' bottoms. Mr. Allen's plan of making a coating or anti-corrosive paints for metals is thus given:—Ammoniacal liquid obtained from coal tar or gas tar, prevents incrustation of boilers, and is applicable to painting the inside plates. Messrs. Pile and Smyth, of West Hartlepool, took out a patent in 1860. They employ a red composition and enamel, consisting of a combination of litharge, Venetian red, and pine varnish. Over this composition is applied a coating of resin, gums, or any pitch or bituminous substance, with the addition of coal tar or oil. This is put on in a hot lava state, and the process is called enamelling. An impermeable oil varnish was patented by M. Antoine Bonet in 1860, composed of 100 parts of alcohol, 100 parts of spirits of turpentine, one part of sulphuric ether, and one of carborate of soda.

Mr. Robert Smith, shipowner, of Finsbury, applied to the Patent-office, in 1860, to protect his system for keeping vessels from fouling and worming. He applies equal parts of pitch, tar, resin, and turpentine, with any other adhesive compound. Assafœtida to be mixed with the foregoing, as a poison to destroy life. When the coting is laid on, and dry, the whole to be covered with paper or cloth. Mr. G. Hallett, in 1860, in his patent explains his method of protecting metal. He grinds the oxide of antimony to powder, then dries it, and mixes with it 12lbs. of linseed oil to the hundred weight of powdered oxide. Mr. Richardson, 1861, to prevent oxidation, would cover the metal with vulcanised india rubber, cloth or gutta percha, the object sought being to provide for unequal expansion of the metal and coating. Mr. Francis Pluz, chemist, 1861, causes oxygen to be passed through sulphuric acid, to render the oxygen more active as an oxydising agent, as it combines when so treated, with other substances for which it has an affinity for manufacturing purposes. Mr. Pluz also, in a second patent, submits oily matters to this oxidising agency, by causing the sulphurated gas to pass through them when in a liquid state. Mr. Martin Miller sends a communication, in 1861, for coating metals or alloys in different ways. Mr. John Hay, in 1861, patented a drying oil. He lays a non-conducting coat, and then makes a paint by grinding in linseed oil the black or protoxide of copper, which is then boiled till reduced to the sub-oxide, and by thus oxygenating the oil he claims to have formed a quick drying cupreous oil. Mr. John Snider, of the United States, patented here a compound, in 1861, for coating metal. He reduces amorphous graphite to fine powder, and then mixes it with ore by the agency of a heated steam pipe. When cool and dry, one pound of oil is added to three pounds of the powder, and when the ingredients are combined, hot pure beeswax, in the proportion of one of wax to 10lbs. of graphite, is mixed. Afterwards linseed oil may be added. Mr. Snider details his manner of manipulating and preparing the graphite and ore. Messrs. Hallett and Stenhouse, in 1861, obtained a patent for the manufacture of pigment for coating surfaces. They employ native oxide of antimony, chemically treated in ways too intricate for explanation in this abbreviated outline, and mixed with red lead or litharge. They sometimes take type metal or worn out types, reduce them to a coarse powder, and then mix them with their own weight of zinc, and calcine them. This produces a yellow pigment.

SHILLITO AND MOOR'S IMPROVEMENTS IN GENERATING HEAT AND MOTIVE POWER.

The importance of being able to burn off usefully fuel from a very small area of grate bars is a desideratum well known. With the view of effecting this desirable object—and of utilising the highly heated gaseous and other products resulting from the combustion of fuel within a closed furnace, coupled with the ability of superheating steam without the necessity for a separate and special superheating apparatus—Messrs. Shillito and Moor, of Hull, have recently invented an arrangement of furnace in which, instead of constructing steam engine and other furnaces in the usual way, and effecting combustion by admitting a free current of atmospheric air beneath the furnace bars alone, or partly beneath the furnace bars and partially through or above the furnace door and on to the burning fuel; (or, as is otherwise usually done) and regulating the combustion of the fuel by the admission of the current of atmospheric air alone, or aided by a steam blast or jet of steam, and with or without the use of a damper, the furnace is so formed as to burn off the fuel within an air-tight enclosure and the amount of atmospheric air necessary for effecting the combustion of the fuel is forced in under the requisite pressure. The emission or escape of the products of combustion from the furnace and flues and passages is regulated by means of a valve, damper, or regulator, or by valves, dampers or regulators capable of being closed air-tight, and the hopper, door or other means of admitting the fuel into the furnace is closed air-tight to resist the requisite pressure. The shape or internal form, and the dimensions of the furnace must be varied, to suit the particular form of boiler, or the purpose to which it has to be adapted, and the air may be compressed to any extent by the well-known means at present in use, such as by pumps, fans and such like apparatus; and, the pressure at which the air is to be employed within the furnace, as also the rate of combustion, is regulated by the escape of the products of combustion through a regulator in the emission pipe or flue.

The air forced into the furnace, under pressure, may be heated to any required extent before it is brought into contact with the fuel.

The gaseous and highly heated products of combustion arising from the burning off of the fuel within the small close furnace may be passed into the boiler and mixed along with the steam and the mechanical force due thereto thus be utilized.

Instead of employing directly the steam, or the steam and highly heated products of combustion combined together, for the purpose of producing motion in the engine, the boiler and its furnace constructed according to this invention may be placed as closely as convenient to a boiler of the ordinary or any suitable kind, and the highly superheated steam or steam and gaseous products combined (generated in the smaller boiler constructed according to this invention) may be passed into the water contained in the larger boiler and so generate steam of sufficient pressure and temperature for the purpose for which it is required to be employed.

The fuel may be fed into the close furnace by means of a hopper with chambers or drop spaces closed with air-tight slides or valves, or the fuel may be fed in by means of a screw or screws, or any other of the well-known mechanical means, enclosed within a chamber or tube.

In every case it is important to thoroughly protect and encase the boilers and furnaces constructed according to this invention, to prevent the great loss arising from the radiation of heat; and as the employment of compressed air for promoting the combustion of the fuel within the air-tight furnace necessitates a furnace with but a very small cubical capacity as compared with the heat abstracting surfaces, these latter should be of as great an extent as possible, and of the best form calculated to abstract the heat and transmit it to the water to be converted into steam.

We may add that some experiments, made with this apparatus, have, we understand, proved of a satisfactory nature; and, as the questions involved are of very considerable importance, we shall hope to be able to again refer to this subject, and lay before our readers the further particulars of the results obtained, when the experiments are concluded.

RAILWAY STATISTICS—LOCOMOTIVE POWER.

Next to traffic charges, the cost of locomotive power is the largest item of the expenses of a railway company. In 1862 the aggregate cost of the railways of Great Britain of locomotive power, including the expenses of all stationary engines, was £3,966,005, or 27·79 per cent. of the gross expenditure of the lines. Locomotive power, of course, includes all the expenses attending the working of the engines by which the trains are drawn; but so much has the cost been felt to depend upon the engine driver, that one of our great companies, not many years ago, entered into a contract with their engine drivers for the working of their locomotives. They were to be paid so much per train mile for working their engines, and were to purchase from the company out of that amount all the fuel and stores they required for the purpose at a fixed scale of prices. Such was the effect of this contract that it was soon found that some of the drivers were netting as much as £20 per week. Of course, the mileage rate was thereupon reduced; and we believe the reductions went on until the drivers at last declined to work at the rates proposed to them. But effect was to bring the locomotive expenses of the company in question to a minimum, to economise the use of stores, and to make the enginemen doubly careful of their engines.

Fuel forms so large a proportion of the cost of locomotive power, that this item of expenditure is, to some extent, affected on different lines of railroad by the facilities of access which the lines possess to coal fields. It is also somewhat affected by the quality of the fuel consumed. There has been much dispute recently as to the relative cost of coal and coke in working locomotive engines; but the cost of locomotive power on those lines which have used the largest proportion of coal does not appear to show so large a disparity as to justify any decided inference in favour of coal over coke. Accessibility to sources of good supply would seem to be

the principle which should rather govern companies in the employment of fuel. Where a supply of good steam coal can be readily obtained there would seem to be little advantage in using coke; but where there are no coal fields, and the engines have to be supplied with fuel carried over long lengths of railway, the lighter the load of fuel to be conveyed, the less will be the cost to the company for its conveyance.

It must be admitted, however, that there are some disadvantages in the use of coals which do not apply to coke. A considerable item of expenditure under the head of locomotive power, consists of wages to engine cleaners. There can be no doubt that coal is the dirtier article, and that the cost of engine cleaning is increased where coal is used. Whether the employment of coal is more injurious to the engine itself is a disputed question, on which present experience does not, perhaps, justify a decided opinion. Complaints have recently appeared in some of the papers that the use of coal is an annoyance to passengers, from the smoke and dust emitted by the engine in which it is employed. But as to this, it should be observed that where coal is most largely employed, as on the South-Western Railway, it is used in engines which consume their own smoke. Certainly it ought not to be used by any engines that do not consume their own smoke. It is easy enough to apply a smoke-consuming apparatus to a locomotive, and the Railway Clauses Consolidation Act (8 and 9 Vic., c. 20) provides that "every locomotive used on a railway shall, if it use coal or other similar fuel emitting smoke, be constructed on the principle of consuming, and so as to consume, its own smoke," under a penalty of £5 for every day on which such engine is used. But this Act, it should be observed, only applies to railways constructed since 1845.

There is one other inquiry with regard to power that is of great importance. From time to time we hear reports, generally of a vague and unsatisfactory character, of some power having been discovered that is likely to supersede the power of steam as a means of locomotion. Now there is one infallible test which may be applied to all proposals to substitute any other power for the power of steam. The test is cost. Locomotive power applied to railway costs, as already stated, something less than 9*d.* per train mile. Can any power be invented that is cheaper? At present the disparity in favour of steam, as compared with the cost of employing any other power at our command, is much greater than is generally known. Taking coal as an unit, it has been established that the relative approximate cost of employing the power at our disposal stands thus:—

Coal...	1
Horse power	10
Electric power	70
Manual power	90

Or, to put it in another form, there may be raised for every shilling spent by:—

Manual power	600,000lb. 1ft. high.
Electro-magnetism	900,000 „
Horse power	3,600,000 „
Steam power	56,000,000 „

Until, therefore, a power is obtained that can raise more than 56,000,000lb. 1ft. high for a shilling, we may rest satisfied that steam power will continue the great motive power of the world. It was observed at the outset that the cost of locomotive power included the working stationary engines. These are now very few and far between on railways, and employed only for the purposes of hoists, or for the working of inclines. For all purposes of traffic, experience has proved the stationary engine to be more costly than the locomotive, as well as less efficient. In working traffic a stationary engine expends an immense amount of its power in counteracting the friction of the rope by which it has to haul the train; and, besides this cause of expense, it has to be kept in readiness to work both night and day, which necessitates double machinery, so that two stationary engines are required where one locomotive would suffice. In addition to these considerations a stationary engine can only work traffic over a space of some three miles at the most, so that on a railway of one hundred miles in length, more than thirty stationary engine houses would have to be erected, and each with duplicate engines; and each train would have to stop at each station house, in order to detach and affix its ropes. Hence, engines of this class are inapplicable to a continuous system of railway traction, and where they were at one time established, they have been abandoned. On the Blackwall Railway, where the stationary engine system lingered last, it was found that engine power equal to the power of 400 horses was required to draw the train on a level, by means of a rope, the distance requisite for its passage over that line. The cost of working would have, alone, compelled the abandonment of the system had not the exigencies of the traffic otherwise necessitated it.

The locomotive engine is, therefore, the cheapest as well as the most effectual form of applying the cheapest and most effectual power with which science has acquainted us; it will work best and cheapest where the road is the most perfect, and where the least resistance is offered from adverse gradients. The more perfect the surface of the line the less the tractive power needed, and the less the tractive force, the less the necessity for size, which implies dead weight, in the machine. This naturally leads to the consideration of the next item of railway expenditure—the sum annually spent upon the maintenance of permanent way and works.

Maintenance of Way and Works.—The annual outlay of the railway companies under this head of charge is £2,708,638 a year, or nearly 79 per cent. of the total expenditure. The cost of maintenance of permanent way varies on different railways from 4*d.* to 8¼*d.* per train mile, the average being about 6*d.*, at which figure some of our largest railways stand. High speed must be regarded as the main governing cause, at the present time, of the expense of maintaining permanent way; and a calculation of the relative outlay of different railway companies under this head certainly appears to bear out this conclusion. Contrasting the cost of these works upon four of our railways, over which trains are run at very high speeds, with the cost on four lines which have equally heavy traffic, but on which trains are run at more moderate speeds, we find the following results:—

Railway.	No of miles. open.	Cost of maintaining way, &c.	Average per mile.
South-Eastern.........	286	£105,254	£368
Great Northern	414	141,670	342
North-Western	1196	393,664	321
Great Western	730	232,040	314
South-Western	515	131,775	256
Midland	647	161,645	250
North-Eastern	895	181,099	202
Great Eastern.........	660	132,805	201

This table is somewhat remarkable as showing the effect of speed alone; because it may be fairly assumed that as regards the weight of the load, the four last-mentioned railways are pretty much on a par with the four first mentioned—the South-Eastern with the South-Western, the Great Northern with the Midland, the North-Western with the North-Eastern, and the Great Western with the Great Eastern; and yet it will be observed that the disparity in respect to the average cost per mile per annum for maintenance of way between the highest speed and the more moderate speed lines is very considerable.

In the case of some lines the exigencies of permanent way have been so much felt as to necessitate experiments of new materials. In the last report of the London and North-Western Railway Company it was stated that they had made a trial of a new description of rail made of steel:—

"The results are important and satisfactory. Some of the rails were laid down at Rugby, Stafford, and Crewe, in March, 1862, and are wearing well. In May, 1862, some were laid down at Camden parallel with the best description of iron rail. So severe was the test that the iron rails speedily gave way, and had to be frequently renewed, worn out, whilst the steel rails continue to show little appearance of wear. Having regard to the importance of procuring the most efficient rail, so as to avoid the frequent renewal now found necessary on the main line and at the principal stations, the directors have found it expedient to adopt and substitute the steel rail to that extent at least, and having agreed with Mr. Bessemer as to the royalty to be paid for the use of his patent, they have made the needful arrangements at Crewe for the production of steel to the extent of 10,000 tons per annum."

Opinions may, and probably will, differ as to the advisability of producing these rails at Crewe, where a first expenditure of no less than £38,000 is required to be incurred for the "erection of steelworks," besides £16,000 for "additional water supply;" items that the shareholders may expect to see very largely swollen in future "requests for votes." But there will be but one opinion as to the desirability of adopting upon this important railway the very best and most lasting description of rail, that which will stand the hardest work, and necessitate the least interruption of the line during renewals. To the North-Western, almost beyond all other lines, it is important to have a durable permanent way; but other companies will watch with no little interest the experiment which the London and North-Western are about to make in adopting "Bessemer's patent" for the passage of "limited mails" and "monster engines."—*Mining Journal.*

REVIEWS AND NOTICES OF NEW BOOKS.

Chemical Technology: or Chemistry in its applications to the Arts and Manufactures. By Thos. Richardson, M.A., Ph. D., F.R.S.E., M.R.I.A., &c., and H. Watts, B.A., F.C.S., Ed. "Journal of the Chemical Society." Second Edition. Illustrated with numerous wood engravings. Vol. I. Part 3. Nos. 1 and 2. London: H. Baillière, 219, Regent-street, 1863.

The rapid strides which during very few years have been made in the application of chemistry to the arts and manufactures, and the numerous and important innovations constantly occurring in chemical technology, having rendered valueless the few good works of reference to which the chemical student and the manufacturer were wont to turn for reliable technical information, the absolute necessity, therefore, of such a work as that under notice cannot be over-estimated, and by no abler hands could the task have been undertaken than Dr. Thos.

Richardson and Mr. H. Watts. The several processes described in the two parts under notice are treated in the most able, clear, exact, and compreheusive, yet succinct manner, and are illustrated by numerous woodcuts interspersed throughout. In fact, the book is excellent in every particular.

A Practical Treatise on the Science of Land and Engineering Surveying, Levelling, Estimating Quantities, &c., with Illustrations. By H. S. MERRETT, Architectural and Engineering Surveyor. London: E. and F. N. Spon, 1863.

We congratulate the author of this book on the successful result of his labours. He has treated of land and engineering surveying in so admirable and complete a manner that there really seems—after a careful perusal of his book—nothing left undone, or for future writers on the subject of surveying to do. The student will find Mr. Merrett's work a perfect *vade-mecum*.

Industrial Biography.—Iron Workers and Tool Makers. By SAMUEL SMILES, author of "Lives of the Engineers," &c. London: John Murray, Albemarle-street, 1863.

Whatever the subject Mr. Smiles essays to treat, success beyond the utmost aspirations of mortal authors invariably attends upon his efforts, therefore, it is needless to inform our readers that the present work, by Mr. Smiles, is a highly interesting book, treating of men to whose genius this country mainly owes its proud pre-eminence amongst the civilised nations of the earth. Amongst those selected by Mr. Smiles for biographical notice, we find mention of the great and well-known names of the Darbeys and Reynoldses, Benjamin Huntsman, H. Cort, D. Mushet, J. B. Neilson, and others connected with the production of iron and steel, and of Joseph Clement, Fox of Derby, Murray of Leeds, Roberts and Whitworth of Manchester, James Nasmyth and William Fairbairn, as mechanical engineers and inventors.

A Record of the Progress of Modern Engineering: Comprising Civil, Mechanical, Marine, Hydraulic, Railway, Bridge and other Engineering Works. Edited by WM. HUMBER, Assoc. Inst. C.E., Mem. Inst. M.E. Part 10 and 11. London: E. and F. N. Spon.

In the part for October 1st, besides giving two plates of details connected with the Lambeth Suspension-bridge, we perceive a great improvement, to our mind, has been introduced for the first time by Mr. Humber into "The Record." He has given some external views and sections of "The Allen Engine" (American), which engine, by-the-by, at first sight, appears to be a "screwed and lop sided" sort of thing, and having apparently scarcely any other peculiarity or merit, except, perhaps, that of difference, as compared with the best designs of properly disposed material, and balanced moving parts in horizontally arranged engines, with which we are familiar. We hope Mr. Humber will continue to issue the parts of "The Record" monthly, as heretofore, instead of (as we perceive it is announced in the November part) in a half-yearly or annual volume.

Experimental Researches in Steam Engineering. By F. ISHERWOOD, U.S Navy. Vol. 1. Philadelphia: William Hamilton, Hall of the Franklin Institute, 1863 (and to be had of H. Baillière, Regent-street, London.)

The author of this elaborately got-up work, the first volume of which has just issued from the press, is already favourably known to the readers of THE ARTIZAN as the chief of the bureau of steam engineering in the navy department of the U.S. Service, and an extensive experimenter in steam economics.

The books previously written by Mr. Isherwood, and noticed from time to time in THE ARTIZAN, are, in a sense, fragmentary works, although possessing great interest; but the present work appears to have been undertaken by the author "with an exhaustive intent;" and judging by the quality and quantity of the matter presented in Vol. I, he must have laboured hard and successfully to have strung together the results of so many experiments—some of them long continued, and many of them faultlessly conducted.

The branch of steam engineering to which Mr. Isherwood, in his present work, more especially addresses himself, will be best conveyed by citing from the front page. "The experimental researches have been made principally to aid in ascertaining the comparative economic efficiency of steam used with different measures of expansion, and the absolute cost of the power obtained therefrom in weights of fuel and steam; the causes and quantities of the condensations in the cylinders; the economic effect of steam jacketing, and steam superheating, and of various proportions of cylinder capacity for the same weight of steam used per stroke of piston; the economic and absolute evaporative efficiencies of boilers of different types and proportions; the comparative calorific values of different coals as steam generators; the performances of U.S. war screw steamers, &c. The whole being original matter, composed of extensive experiments made by the U.S. navy department."

Amongst the various experimental researches, of which exact details are given, we may quote the following:—

"Comparative experiments on steam in the saturated state, and adheated according to Watermann's system, made with a view to determine their relative economic efficiency in support of fuel to power developed by a steam engine."

In these, as in all the following experiments, very ample details are given, and the dimensions of the engine and apparatus, boilers, &c., a description of the manner of making the experiments, and tabulated results are so well arranged as to readily and correctly present the whole to the mind of the reader.

The pumping engine of the Brooklyn Water-works is described, and the results in the same methodical manner.

Then follows a report made to the navy department by the Board of the U.S. Naval Engineers, convened on board the U.S. steamer *Michigan*, at Erie, Pa., Nov. 19th, 1860, to determine the relative economy of using steam with different measures of expansion. Additional remarks in connection with the foregoing report are given, and some pertinent observations on the truth of the indicator as a meter of power, on the dynamic value of one pound of steam, used without expansion, the causes of the condensation of steam in the cylinder, the value of steam jacketing and steam superheating, and on the application of the laws of Mariotte to vapours and gases.

A very interesting series of experiments on the evaporation given by the vertical water tube boilers of the U.S. steamer *Michigan*, with the Ormsby and Brookfield coals, and with the anthracite used in the experiments made with the machinery of that vessel, to determine the relative economy of using steam with different measures of expansion. The results here defined, and those made with boilers, &c., of other ships are valuable.

A large number of details are given of the U.S. screw frigates *Merrimac*, *Wabash*, *Minnesota*, *Roanoke*, and *Colorado*, and their machinery, and the logs of these vessels when working under various conditions; and a comparison of their performances are deducable therefrom.

The U.S. screw sloop *Brooklyn* is described, and her dimensions, and that of the engines, boilers, and machinery, and their respective performances are given in detail.

The experiments to determine the evaporative efficiency of the boiler of the U.S. steamer *Jacob Bell*, with anthracite, are given in detail, and the results tabulated.

Experiments to determine the evaporative efficiency of the U.S. steamer *Mount Vernon*, with anthracite, and with Cumberland semi-bituminous coal and experiments to determine the evaporative efficiency of the U.S. steamer *Valley City*, with anthracite, and with Cumberland semi-bituminous coal, and experiments to determine the evaporative efficiency of the U.S. steamer *Crusader*, with anthracite, will have great value assigned to them by the English marine engine builders.

Experiments to determine the relative evaporative efficiency of the boiler of the U.S. steamer *Wyandotte*, with the usual arrangement of furnace, and with the "Amory-bridge" applied. Also to determine the relative evaporative efficiency of the boiler with Blackheath anthracite, and with broad top semi-bituminous coal, under various conditions of thickness of fire, and of admission and suppression of air through holes in the furnace doors, are all useful in their way, and will prove valuable when contrasted with the results of English experiments.

Experiments to determine the evaporate efficiency of the *Underwriter*, with Anthracite and Cumberland semi-bituminous coal, and experiments to determine the evaporative efficieucy of the *Young American* with anthracite.

The foregoing very comprehensive experiments upon the several steam boilers of vessels in the U.S. navy will prove of the highest possible interest to our engineering friends "on this side Jordan."

A series of experiments were made on the machine shop boilers of the New York navy yard, with Locust Mountain and Blackheath anthracite, to determine their relative evaporative efficiency; and, also, the effect produced upon the economic evaporation of the boiler by continuously diminishing its heating surfaces and calorimeter by stopping up successive rows of tubes; and another series of experiments made with the machine shop boiler of the New York navy yard, on the anthracites, semi-bituminous, and bituminous coals from the principal localities mined for the New York and Philadelphia markets in 1862, to determine their comparative evaporative efficiency, are useful, particularly when the exact character of each fuel used is known, and can be compared with the various English coals.

Experiments made with the machinery of the U.S. iron-clad steam battery *Monitor*, to determine the cost of the indicated horse-power in pounds of steam and fuel per hour, when using the steam expansively and without expansion; and to determine the evaporative efficiency of the boiler with anthracite; and, finally. experiments made with the machinery of the U.S. iron-clad steamer *Passaic*.

Each series of experiments is completely worked out and generally tabulated; and wherever it is possible to give an illustrative diagram or a plate engraving, the author has introduced it.

Mr. Isherwood has been unsparing in his labours to render the work complete, and he has succeeded; and we shall hail with considerable satisfaction the appearance of the next, and of any additional volumes of "Experimental Researches in Steam Engineering."

BOOKS RECEIVED.

"The Glasgow University Calendar for the Session 1863-4." Glagow: Geo. Richardson. University Press, 55, Glassford-street.

"Description of Richards' Improved Steam Engine Indicator," with directions for its use. By CHARLES T. PORTER. London: Elliott Brothers, 149, Strand, 1863.

NOTICES TO CORRESPONDENTS.

J. B.—Your communications are attended to. We have given the necessary instructions, and shall be glad to hear from you from time to time.

INQUIRER.—We have now in course of preparation some particulars of steam vessels, which we purpose giving in an early issue. The vessel to which you refer will, if possible, be included in our list.

J. W. W., Newcastle-on-Tyne.—We await receipt of your decision, and the particulars promised.

R. Y.—There is a system of working railways by stationary engines, which should meet the requirements of the case to which you allude. We refer to

that of Messrs. R. and W. Hawthorn, of Newcastle-on-Tyne, who read a paper upon the subject at the last meeting of the British Association. You will find a description and illustrations of the plan in THE ARTIZAN of last month.

W. C. R.—Communications received, and the particulars used with thanks.

X.—The steam trap to which you refer is the invention of a Mr. G. W. Furman, of New York, and we have, at your request, given illustrations of the apparatus. Figure 1 is a sectional view of the trap. A, the outside shell; B, the globe or float; C, a slide valve on the stem; D, the passage through which the water

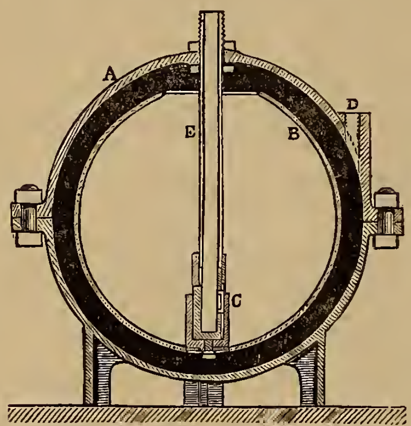


FIG. 1.

enters the trap; and E, the stem through which it is passed off. When the trap is set, there is water enough poured into the outside shell A, to float the globe B, and close the valve C, which will remain closed, preventing the passing off of either steam or water until the latter has filled the globe and sunk it, when valve C opens, and the pressure of steam forces the water through pipe E. So soon as the water has passed out of globe B, it will rise and valve C close, preventing the passage of steam as before. Fig. 2 illustrates the mode of attaching the trap to the steam chest of a vertical engine.—*Directions for using the Trap.* When this instrument is attached to an engine, the check-

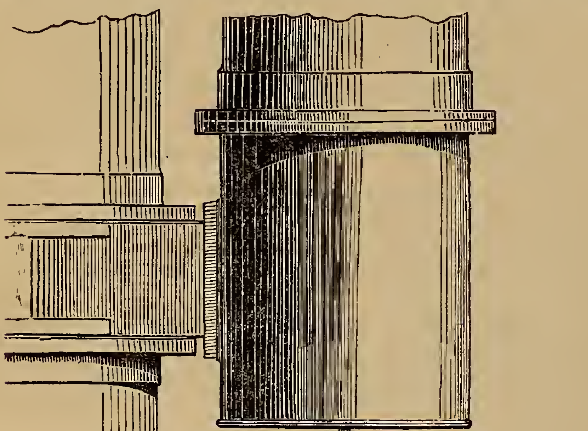


FIG. 2.

valves must be placed horizontally, so that the water will flow freely through them. The same end of the valve that is placed next to the pump for feeding the boiler, must be placed nearest to the flow of water from the engine. It requires to be so far filled with water, before first getting up steam, that globe B will float. If, by any accident, the slide-valve C becomes obstructed, and the steam blow through, it will be necessary to add sufficient water to again float globe B, which may be done by closing the cocks in the connexions, so far as to permit the water to pass into the trap in small quantities, or by pouring it through the hand-hole. Before starting the engine, after lying idle for several hours, open the air-cock on the top of shell A, and let it remain open until the air collected in the engine has passed through it. The valves connecting the trap with the engine *should always be open.* When much lubrication is resorted to in the cylinder, the check-valves may occasionally require to be cleaned of gum or grease. If, from the same cause, the slide-valve C becomes obstructed, it may be relieved by putting a small quantity of

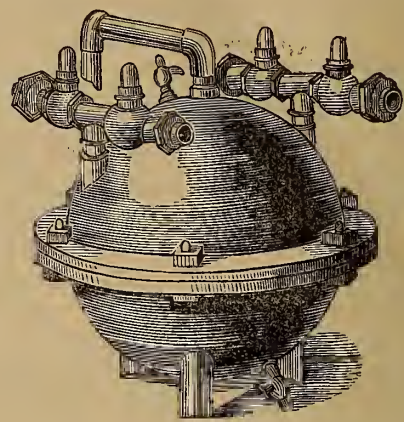


FIG. 3.

potash in globe B. So, too, if there ever be an accumulation of grease in shell A, it can be cleaned in the same manner. The trap can be relieved of dirt by removing the bonnet from the lower hand hole, and blowing steam through it. Fig. 3 illustrates the manner of attaching the trap to locomotive engines.

ERRATA.

In THE ARTIZAN for November, the following *errata* occurred at page 247, descriptive of Messrs. R. and W. Hawthorn's Method of Working Railways by Stationary Engines. Paragraph 6 from top, line 4, for *guard*, read *driver*. Paragraph 10 from top, line 3, for *bridges*, read *bogies*. Second column, line 2 from top, for *unmeaning* read *unnecessary*. In the Discussion, paragraph 9, line 1, for *using* read *wearing*.

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

SPENCER *v.* JACK.—This was an appeal from an order of the Master of the Rolls. The plaintiff was an engineer at Newcastle, and in July, 1860, he took out a patent for an improved method in condensing steam for working steam-engines on board ships. It appeared from the specification that the plaintiff claimed as his invention a new combination of well-known matters—namely, surface and jet condensers of steam, which produced new and valuable results. The bill was filed to restrain an alleged infringement of the patent of the defendant's engineers at Liverpool, and, upon the application to the Master of the Rolls for an injunction, his honour directed issues at law to try whether the patent of the plaintiff was a new and useful invention, whether it had been sufficiently described in the specification, and whether there had been any infringement of it by the defendants. The jury found in favour of the plaintiff on all the issues, and an application for a new trial was made to the Master of the Rolls on the following grounds: First, that there had been a misdirection of the Lord Chief Justice of the Common Pleas; second, that the verdict was against the evidence; third, that there had been a miscarriage; and fourth, that the defendant had been taken by surprise. The Master of the Rolls granted a new trial, and, upon appeal from that order to the Lords Justices, their lordships suggested that the matter should be brought before the Lord Chancellor. The Lord Chancellor said that, looking to the facts as submitted to him, he must find for the validity of the plaintiff's patent, at the same time he did not consider that there had been an infringement of it by the defendant such as would come within the term of the plaintiff's specification. He must reverse the order of the Master of the Rolls for a new trial, but dismiss the plaintiff's bill without costs.

CLIMIE *v.* BUCKLEY RAILWAY COMPANY.—AWARD OF ARBITRATORS.—The plaintiff in this case had constructed the defendants' railway upon a contract, but there being a large claim for extras, a dispute arose, and the matters were referred to arbitrators, who

awarded that the defendants should pay the plaintiff £10,624 7s. 1d., and £902 4s. 5d. A few days ago the court granted the usual rule calling upon the defendants to show cause why they should not pay the above sum pursuant to the award. Mr. Lush, Q.C., and Mr. Watkin Williams, in showing cause, stated that one of the conditions of the contract was that the plaintiff should accept in part payment any number of shares not exceeding 400, at their nominal value of £10 each. The plaintiff, however, now contended that he was not bound to take the shares, because the arbitrator had awarded him so much money; but it was submitted to the court that the arbitrator had simply fixed the amount due, without in any way interfering with the mode of payment settled by the contract. Mr. Gray, Q.C., in support of the rule, stated that there had been certain proceedings in parliament varying the formation of the company, so that the existing shares were not the same things as those mentioned in the contract. Besides, all the shares had been allotted, but after the award the company went into the market and bought shares to tender to the plaintiff. After some discussion it was arranged that the question whether the plaintiff was bound to accept the shares, should be tried by an action or a special case, and that the remainder of the amount awarded should be paid.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Steam Hammer.—Messrs. Thwaites and Carbutt, of Bradford, Yorkshire, have recently finished a 15-ton steam hammer of large size. It has an 8ft. stroke, and the standards, which are on the hollow box principle, are 20ft. wide and between 18ft. high, so as to give ample room for the men to work under. The hammer itself weighs nearly 70 tons; the anvil, block, and bed plate, 150 tons. Although it is made on the Nasmyth principle, it has a few novelties about its construction. The great width and height between the standards, necessitates a means of staying the two together, to prevent them from spreading, in consequence of which they were brought together and bolted up the middle; and instead of a rectangular tup, these have been bored out, and a round tup used; also, by this means, a greater resistance is interposed to the strains of a side blow. To insure lightness and strength in the piston, so as to lessen the strain on the piston rod, it has been made of steel 1in. thick, with a double corrugation.

Supply of Cotton.—Mr. Cheetham gives the following estimate of the amount of cotton likely to reach us next year:—India, 1,500,000 bales; Egypt, 380,000; Brazil, 185,000; America, 100,000; West Indies, 35,000; Turkey, 150,000; China, 150,000; Italy, 25,000; total, 2,115,000 bales. The final and practical conclusion drawn by Mr. Cheetham is that, instead of four days and a half work per week, as Mr. Ashworth believes, the mills will work only four days. He also conjectures, in opposition to Mr. Ashworth, that the month of January at any rate must be expected to pass before any considerable portion of this supply will be available, so that, upon the whole, instead of seeing the cotton trade revive at the very beginning of the year, and continue active at the rate of four days and a half a week, we must expect to wait till spring for the recovery, and then deduct half a day per week from the average working time of the mills.

Steam Engines.—It appears that, notwithstanding the great progress which the colonies and continent have made in the production of steam engines of late, the demand for British motors of this description was larger last year than ever. Thus, the value of steam engines exported in 1848 was £234,182; in 1849, £152,519; in 1850, £423,977; in 1851, £403,637; in 1852, £338,222; in 1853, £458,376; in 1854, £509,768; in 1855, £883,370; in 1856, £819,067; in 1857, £1,069,219; in 1858, £1,007,278; in 1859, £937,340; in 1860, £1,238,333; in 1861, £1,258,104; and in 1862, £1,631,761. Probably the demand for locomotives for Indian and Australian railways has swelled the figures of late years; but, whatever the cause, the state of affairs indicated must be regarded as satisfactory.

New Pier at Bankside, Southwark.—On the 2nd ult. a new and commodious pier, constructed by the Conservators of the River Thames, in compliance with a requisition from a large body of traders and inhabitants of the Southwark side of the river between London-bridge and Blackfriars-road, was opened for the landing and embarcation of steamboat passengers. The new pier communicates with Emerson-street, Southwark, and is nearly opposite St. Paul's Pier, Queenhithe. It will open up the river communication for a long time required between the north and south sides of the Thames, and supply the deficiency of accommodation caused by the removal of the pier at Southwark-bridge. It is understood that steps will be taken for extending similar pier accommodation to other points and places on the Surrey side.

Cotton Culture in Sicily.—Professor Francesco Tornabene, manager of the Simeto Embankment Company of Catania, has just published his report, addressed to the Commissioners of Agriculture of Sicily, on the results of the irrigation works connected with the embankment of the above river. It appears from this return that on the shores of the Simeto 226½ "salme," equal to 977·63 acres of land, are at present planted with cotton, 58 "salme," or 250·3 acres of which belong to the order of the Benedictines. The irrigation of the ground takes place four times per month, at a rate of 1,[illegible] litres of water per "salma legale," i.e., 22·147 cubic inches of water per acre of ground. The quantity of seed used has been hitherto 1½ quintals on each salma, or [illegible]lb. per acre. The species of cotton planted is the white and red Siam (Gossypium Siamense). The report does not state what results have been derived hitherto from the culture of cotton on the Simeto.

The River Tees.—An important work has been commenced at the mouth of the river Tees. The foundation-stone of an extensive breakwater has been laid. The object of the breakwater is not only to improve the navigation of the river Tees, but also to increase the safety of the estuary of that river, so that it may serve as a harbour of refuge for shipping which may be caught in the many gales which prevail on the north-east coast. The work, which it is calculated will cost several hundred thousands of pounds, will be performed from plans by Mr. John Fowler, engineer, under the auspices of the Tees Conservancy Commissioners, who have obtained £30,000 from the Public Works Loan Commissioners. Although the foundation-stone of the breakwater was not laid until very recently, the work of the breakwater itself was commenced more than a year ago. Many thousands of tons of "slag," or refuse, from the ironworks of the district have been deposited on the line of the intended pier, the "slag" wall now stretching a mile or so across the beach from the water line, a mile west of Redcar towards the sea. The "slag," it is said, has been obtained at the nominal cost of ½d. per ton.

The London Coal Trade.—For the month ending the 31st of October last, 503,205 tons 4 cwt. of coal and coke were entered in the port of London, against 438,301 tons 16 cwt. for the corresponding month of 1862, showing the large increase of 64,903 tons 4 cwt. Of this quantity 192,859 tons 14 cwt. came by railway,—viz., Great Northern, 74,199 tons 8 cwt.; London and North-Western, 72,748 tons 1 cwt.; Great Eastern, 22,588 tons 8 cwt.; Great Western, 10,733 tons; Midland, 8595 tons 13 cwt.; South-Western, 3251 tons 7 cwt.; Chatham and Dover, 684 tons 17 cwt.; and Tilbury and Southend, 58 tons. Up to the 31st of October for this year the quantity by railway has been 1,430,013 tons 12 cwt. against 1,186,450 tons 17 cwt., so that 243,592 tons 15 cwt. more coal has been received at London this year than in the first 10 months of 1862. The canal receipts have been 631 tons 10 cwt., against 1190 tons 15 cwt. for October, 1862, and this year this particular traffic has declined 8101 tons 15 cwt., as against 10,200 tons up to October 31st, 1862, or a decline of 2098 tons 5 cwt. The seaborne coal reaches 309,614 tons, being a slight advance upon the tonnage of October last year, when 302,845 tons were entered. The quantity from Newcastle-upon-Tyne was 118,095 tons; Seaham, 17,407 tons; Sunderland, 97,318 tons; Middlesborough, 6831 tons; Hartlepool and West Hartlepool, 53,033 tons; Blyth, 1519 tons; from Wales, 6216 tons; from Yorkshire, 3115 tons; from Scotland, 1451 tons; and from Duff, 317 tons. Small coal, 2727 tons, and 1585 tons of cinders. Comparing the present year with the last, the seaborne coal has declined considerably, for whilst, in the first 10 months of 1862, 2,770,459 tons of coal came to hand in 8540 ships, this year it has been 2,692,908 tons in 7963 ships, or a diminution of 576 ships and 77,551 tons.

Government Experiments with Steam Coal.—In consequence of the repeated applications made by the North country proprietors, a series of experiments, extending over five weeks, have been concluded at the Devonport dockyard. The Admiralty were induced to make these experiments in consequence of the assertion of the North country owners that a judicious mixture of the North country or Hartley coal with the South Wales steam coal was far superior for the purposes of steam than either taken separately. The South Wales proprietors, feeling the importance of the issue, appointed Mr. Tomlinson, locomotive engineer to the Taff Vale Railway, as their representative; and, although some time must elapse before the official report is printed, it may be stated that the results will show that in no way has the superiority of the Welsh coal been affected, but, on the contrary, none of the mixtures experimented upon came up to the generating powers of the Welsh coal taken alone. This must be a gratifying result to the South Wales owners, who, in addition to the navy, have been supplying for some time past large private steamship companies—such as the Royal Mail, Peninsular and Oriental, and Cunard lines, which fact may be taken as presumptive evidence of the superiority of the Welsh coal, as these companies have every inducement to purchase the best article in the market. It is probable that when the official report of these trials is published the question of Welsh v. North country steam coal will be permanently settled.

Turbines on a small Scale for Domestic and Trade Use.—In a house at Manchester, a water-wheel 4ft. in diameter, consuming fifteen gallons of high-pressure water per minute, formerly employed to work the bellows of an organ in the drawing-room over the cellar wherein the water power was produced, has been replaced by Mr. Schiele, with a turbine only 1½in. in diameter, with a 3in. case 1½in. wide, supplied by a ⅜in. pipe, and consuming less than a gallon of water per minute. By a simple regulator the organist can supply his instrument with the required wind by simply giving a turn to a handle near the organ. By availing themselves of the ample supply of high-pressure water in Manchester and other towns, "all persons using machines requiring a small amount of power, now appear to have supplied to them by this invention the means of working their machines with no trouble and at a trifling cost, while at the same time this kind of turbine appears to be equally well adapted for turning large mills and works, even when they require several hundreds of horses' power."

The Middle Level.—It appears from the accounts for the financial year ending April 6, 1863, that the sum of £86,671 was disbursed during that period—£57,711 in reference to works consequent on the failure of the out-fall sluice. A leakage and some disturbance at the syphon dam and works have lately occurred, and Mr. T. E. Harrison, C.E., came down for the purpose of making an examination with Mr. Lunn, the resident engineer. Mr. Lunn has given directions to have some puddle prepared, and the men employed will open out as far as they can the course of the water, and will then fill the excavated space in with puddle. It appears from the accounts that in the commissioners' last financial year the amount taken up on loan was £71,000, the bonded debt of the commission being thus increased to £161,000. The amount paid for interest was £16,693, and the sum received in taxes was £21,691, while the other ordinary necessary receipts of the year were £820. A temporary loan of £20,000, contracted in 1862-3, has been paid off.

Pneumatic Despatch Tubes.—The Pneumatic Despatch Company are about to lay down an enormous tube for the transmission of letters and parcels from their station in Holborn to a station to be established near the General Post-office, in St. Martin's-le-Grand. It appears a tube of that kind already exists between the North-Western district post-office, in Eversholt-street, and the Euston terminus of the London and North-Western Railway, and that the letters have been carried between those parts since the beginning of February last. It is now proposed to lay a tube from the Euston Station, through Woburn-place, Southampton-row, and King-street to Holborn, and thence along Holborn, Skinner-street, and Newgate street, to the General Post-office. This tube is to be of cast iron, 4ft. high and 4ft. 6in. wide, internally. At the city boundary it will be 11ft. 6in. deep, and at Hatton-garden 18ft. 6in., from which point its depth decreases. The tube will pass over the Fleet sewer at a depth of 6ft., and then under the London, Chatham, and Dover Railway. At the west end of Newgate-street it will be 25ft deep, and at the east end 14ft.; its mean depth in St. Martin's-le-Grand being 12ft. When completed, the transmission of all letters in bulk between the General Post-office and the North-Western Railway will be effected by its agency, as will also large parcels of goods. An arrangement has been made with Messrs. Pickford to forward parcels from their depôt in Gresham-street to the North-Western Railway, and an extension of the tube into their premises is ultimately contemplated. This line of tubing, moreover, is understood to be but the commencement of a system which is to be eventually extended to the various metropolitan railway stations, and probably to connect all the district post-offices in London. The Pneumatic Despatch Company have powers under their act to lay down tubes within the city, subject to certain control or direction on the part of the Commissioners of Sewers.

Holborn Valley Improvement.—Notice of intended application to Parliament in the next session has been given, to authorise the Corporation of London to make a viaduct

for the purpose of a high-level street commencing on Holborn-hill, near Ely-court, passing Hatton-garden, Ely-rents, Ely-place, and terminating in Skinner-street, near the Old Bailey. The following improvements are specified in connection with the scheme:—A new street, commencing near the conjunction of Hatton-garden with Holborn-hill, and terminating in Farringdon-road, near West-street; a new street, commencing near St. Sepulchre's Church, Skinner-street, and terminating in Farringdon-road, about 50 yards to the north of Snow-hill; a new street, commenced by a junction with Shoe-lane, near St. Andrew's Church, passing under the viaduct, and terminating in the intended new street, at a point about about 45 yards west of its intended junction with Farringdon-road; a widening on the western side of Farringdon-road, commencing near Newcastle-steeet and terminating about 230ft. north of New Charles-street; power to alter and improve the levels of the western approach to the Metropolitan Meat and Poultry Market in Smithfield; to widen the western end and northern side of Newgate-street, commencing at the corner of Giltspur-street, and terminating at and including No. 105, Newgate-street; and to widen King-street, commencing near its junction with Snow-hill. Powers are also sought to charge the expenses of the works to be authorised upon the duty referred to in the 2nd section of the London Coal and Wine Duties Continuance Act, 1863, to authorise the appropriation to that purpose of any monies arising from that duty, and to authorise the corporation to raise money on mortgage or annuity, and to apply for the above purposes any monies under their control.

NAVAL ENGINEERING.

Trial of the Screw Launch "Experiment."—The official trial of this little craft, which has been fitted by the steam factory department of Portsmouth dockyard expressly, by order of the Admiralty, in order to obtain certain data relative to the merits of the double or twin screw system, has taken place. The *Experiment* is a first-class line-of-battle ship's launch, 42ft. in length, and of proportionate breadth and depth. Her engines and boilers have been made for her according to the designs of Mr. Andrew Murray, the engineer of Portsmouth dockyard, and are models of workmanship and compactness of form. Boiler and engines occupy a space in the centre of the boat of only 6ft. 11in. by 4ft. 4in., the nominal horse-power of the engines being 3, the length of the stroke of piston 6in., and the diameter of cylinder 4in. The total weight of engines and boilers, with platform, coal-boxes, &c., and with boilers fitted, is 2½ tons. The cylinders are brought on to each side of the boiler and drive their independent shafting through each quarter with screws attached to the latter of four blades, each screw having a diameter of 2ft., and a pitch of 3ft. 4½in. The draught of water of the launch, at the commencement of the trial, was 2ft. 6in. aft., and 1ft. 9in. forward. The following was the result of the trial:—

	Time. m.	s.	Knots.	Pressure of Steam. lbs.	Rev. of Engines.
First run	8	3	7·453	55 to 50	290
Second run	10	57	5·479	55 to 50	280
Third run	7	15	8·275	60 to 55	200
Fourth run	11	28	5·232	60 to 55	280
Fifth run	7	19	8·200	60 to 58	290
Sixth run	11	10	5·373	59 to 55	280

Mean speed of the six runs, 6·742 knots.

The revolutions of the engines averaged 290 at 60lb. pressure of steam, and with that pressure the *Experiment* will realise a good seven knots. On this occasion, from a cause which can be easily remedied in future, the steam, as will be seen by the foregoing figures, could not be kept at 60lb., and consequently the vessel lost speed. On the conclusion of the speed trials the vessel was next tested in making circles as follows:—With both engines going ahead at full speed, with the rudder acting, a complete circle was made to starboard in 1min. 9sec., and to port in 1min. 13sec. The circle was next made with one engine shut off, and with the port engine standing (the helm still being brought into use) a circle was made in 1min. 31sec., and with the starboard engine shut off in 1min. 27sec. Reversing the motion of the respective engines, and with the starboard engine going ahead and the port astern, the circle was made in 2min. 9sec. Repeating this experiment, but with the starboard engine astern and port ahead, the circle was made in 1min. 43sec. The diameter of the circles made, as near as could be ascertained without actual measurement, was, with both engines going ahead and rudder acting, rather under three times the length of the launch; with one engine shut off, rather over that distance; with engines reversed, and screws, therefore, working opposite ways, the launch turned on a pivot just abaft her centre, and within her own length, gradually working spirally and astern. The screw launch *Experiment*, made her second official trial, on the 7th ult. On reaching the measured mile in Stoke's-bay four runs were made, with both propellers working, with the following results:—1st run, 6·394 knots, steam pressure, 60lbs.; 2nd, 7·114 knots, steam pressure, 62lbs.; 3rd, 6·428 knots, steam pressure 62lbs.; 4th, 7·128 knots, steam pressure 62lbs. The mean speed of the four runs was 6·780 knots. The evolutions of the engines ranged from 302 to 304. Two runs were next made with one propeller (the port) only working, the results being:—1st run, 4·551 knots, steam pressure 60lbs.; 2nd, 4·675 knots, steam pressure 60lbs. The mean speed was 4·613 knots; the revolutions of the engines ranged from 320 to 360. These results being found sufficiently conclusive as to the boat's speed, using both or only one propeller, she was next tested in making circles, which was completed as follows:—With both propellers going ahead—Half circle to starboard, 35sec.; to port, 32sec.; full circle to starboard, 1min. 8sec.; to port, 1min. 8sec. The diameter of the circle was nearly three times the boat's length. With one propeller driving ahead and the other astern, the following results were obtained, the boat, as will be anticipated from previous trials with twin screw vessels when driving their screws in opposite directions, revolving after the fashion of a turntable, but with a spiral motion astern:—Half circle, to starboard, 35sec.; to port, 32sec.; full circle, to starboard, 1min. 57sec.; to port, 1min. 37sec.

"The Caledonia."—This armour-plated ship is of the same class as the *Royal Oak*, the only difference being that the engines of the *Caledonia* are of 200-horse power more than those of the *Royal Oak*, and the build of the *Caledonia* is of much greater strength. The backing of the armour-plates of the *Caledonia* is composed of 8in. of teak planking, which also forms the external planking of the ship. The backing is firmly bolted to the usual frame timber 12½in. square, near the ports, and is composed of English oak. The clamps, or internal planking of the ship, are also of teak 8in. thick. Great care has been taken in the *Caledonia* to give unusual strength to the fabric. Among others may be enumerated the diagonal iron riders, which are placed on the outside of the frame timbers instead of on the inside, the better to resist the impact of shot on the armour. The space between the shelf pieces and water ways, generally a source of weakness, has been filled in solidly, and secured to the beams and frame timbers. Great additional strength has also been given to the ship by means of an iron deck secured to the beams of the upper deck, underneath the usual wood deck of 4in. thick. The main deck beams are of oak, 16½in. square, with deck planks of Dantsie oak 4½in. in thickness. The upper deck beams are of the Butterly Company's best iron. The port-lids are of iron secured with wrought iron hinges and bars with screw bolts and nuts. The ship is to be rigged with three masts, the lower masts to be of iron; the foremast 77ft. above the deck, and 3½in. in diameter; the foretopmost 78ft. in length, and 18in. in diameter. The fore and main yards are 91ft. long and 22in. in diameter, and the other masts and yards in proportion. She will be fitted with double topsail yards, together with the usual topgallant yards. The boats of the *Caledonia* will be armed with the usual Armstrong 20-pounders. They will consist of two launches, each 42ft. in length; one gig, 30ft.; one jolly boat, 16ft.; and one dingy, 14ft. long. The armour plates, which have proved to be of excellent quality, were supplied by three different manufactories, and at various rates, from £30 to £40 per ton, some of the plates being hammered and others rolled. Messrs. Brown and Co., of the Atlas Works, Sheffield, and Messrs. Beale, of Rotherham, were the manufacturers of the hammered plates. The *Caledonia* has been fitted with two towers on her upper deck for the officer of the watch and the captain and master to stand in during the time of action. These are considered to be preferable to the single tower with which the *Warrior* was supplied, as they are clear of the masts and funnels, which obstruct the view from the single tower. These towers are to be plated with iron casing 4½in. thick, and are accessible through a scuttle from the main deck. To prevent the oxydation of the lower tier of armour-plates from the galvanic action of Muntz's metal two strakes of teak wood lining have been fitted, so that the lower edge of the plates is nearly 2ft. from the upper edge of the metal.

The "Lord Warden" Iron-clad Wooden Frigate.—The following will be the dimensions of the armour-plated wooden frigate *Lord Warden*, the preparations for building which have been commenced beneath No. 7 shed at Chatham dockyard, where she is to be constructed:—Length between the perpendiculars, 280ft.; length of keel for tonnage, 233ft. 11in.; extreme breadth, 59ft. 9in; breadth for tonnage, 58ft. 2in.; depth of hold, 20ft. 9in. Unlike the other vessels of her class hitherto built, the *Lord Warden* will be provided with the same thickness of armour-plating throughout, and the principle of furnishing our vessels of war with guns at the bow as well as at the broadsides will be practically recognised for the first time by the Admiralty by the construction of a bow battery at the fore part of the *Lord Warden*. The stem will project some 8ft. or 9ft. below the water, which will render the *Lord Warden* more formidable as a ram than any of the existing iron and iron-clad war ships. It does not appear to be finally settled whether the twin-screw principle is to adopted in the *Lord Warden*, or whether she will be constructed to carry merely the ordinary single screw, though, from the marked success which has attended the introduction of the double screw in those ships in which it has been tried, it is probable that the *Lord Warden* will be constructed to carry two independent screw propellers, both working by means of separate engines. The sheds adjoining that under which the *Lord Warden* is to be laid down are being fitted with overhead tramways to facilitate the removal of the timber and iron plates.

Variations of the Compass.—A French paper publishes a letter on the deviations to which the needle is liable in consequence of the substitution of iron for wood in ships. One of the latest contrivances for diminishing this serious inconvenience is the correcting compass, which affords the means of taking the sun's position, whereby the deviation may be corrected. It has sometimes been supposed that fogs and certain other states of the atmosphere could influence the needle; but this has not been borne out by observation. Lightning alone exercises a decided influence on the needle by reversing its points so that north becomes south, and conversely. When a vessel is nearing land, the needle is said to be affected; and certain rocks there are that exercise a decided magnetic influence on the compass, volcanic rocks especially, but this influence is not felt on board ships. But the action of the iron forming the ship's sides is far different; nothing, not even the interposition of a thick non-magnetic body, will stop its influence; far less, as some have believed, a copper coating or thick paint. But the real danger proceeds from another source, since the ship herself, under her weight of canvas, may increase the deviation of the needle. From experiments made on board an iron-built sailing vessel, provided with iron rigging and lower yards of steel, and with two binnacle compasses on her poops, and a third placed between the mizen and mainmasts, the lower part of which was all of iron, the deviation of the needle were respectively 56 deg., 24 deg., and 35 deg. Without entering into further details on this matter, the writer of the article concludes with condemning the imprudence of those who freight an iron vessel before she has been at sea for a considerable time, in order to ascertain how her compass behaves. Moreover, a captain undertaking the command of an iron ship should be called upon to show that he has previously been on board such a vessel on a long voyage, so that he may know how to deal with the deviation observable on board the vessel to be commanded.

Warren's "Impregnable and Unsinkable Floating Casemate Battery," &c.—Mr. William W. Warren proposes a system of construction for an "impregnable and unsinkable floating casemated battery, submarine gun and armour plating adapted for stationary batteries, and for convoying troopships," &c. In an abridged, but still a lengthened description, he says:—"I prefer constructing the centre portion of the vessel of rolled wrought-iron double-flanged vertical ribs, from 12in. to 18in. wide, and from 2in. to 4in. thick, firmly rivetted and bolted together, or of angle or T iron,—solidity and stiffness being the great object,—on which are placed the various layers of malleable metals, taking care to stop all chemical or galvanic action, by means of bituminous composition, mixed with hair; and were it not for the cost I would prefer using the finest copper-plating only over the iron, so as to act on the principle of a gradual tenacity of resistance, thereby easing and stopping the momentum, and distributing the shock, and thus prepare the iron-plating to finally resist, without splitting or destroying the plate; or the roof-deck and sides of centre position of battery can be protected with oak, or other wood, compressed in short lengths, and confined, the cross-grain of wood being opposed to the action of fire." Mr. Warren's invention has been presented to the Admiralty, and he has permission to erect a target at Shoeburyness on his compressed wood cross-grain principle; but the cost, which is £5000, prevents him.

Double-bottom Ships of the Royal Navy.—The iron war frigate *Bellerophon*, recently commenced at Chatham Dockyard, will be constructed on what is termed the double-bottom principle. Throughout the central portion, in which the engines, boilers, magazines, &c., are placed, the bottom will be double, the inner and outer bottoms, or hulls, being placed from 3 to 4ft. apart, in order that there may be ample space between for cleaning and painting. As this space, between the two bottoms, will not be required for use, it will be divided into numerous water-tight compartments in the usual manner, and will, consequently, form a series of buoyant cells, any one or more of which may be injured without the sea being admitted to the others or to the ship. Beyond the central portion of the ship, at either end, Mr. Lungley's principle will be introduced, the lower deck being used as an interior bottom, and the space below it made available for stowage by means of iron water-tight trunks rising above the water line. It is this combination of water-tight trunks with water-tight decks—the former being intended as a means for entering below the latter—which constitutes what is known as "Lungley's unsinkable principle," by aid of which not only is the division of the vessel into water compartments accomplished without obstructing ventilation, but the vertical trunks themselves form ventilating apparatus. In addition to the above the *Bellerophon* will be constructed with water-tight internal walls, completing the double bottom, and thus will, in fact, be made a double ship from end to end. With this system of construction the necessity for internal bulkheads is almost entirely done away with, since no ordinary injury could, in any way, jeopardise the safety of a ship so built. The *Bellerophon* is, however, to be furnished with some few bulkheads of the ordinary kind, but these will be so placed as not to interfere with the free and ample circulation of air throughout the ship.

The "Falcon," 17, screw corvette, made her official trial of speed at Portsmouth on the 10th ult., under the superintendence of Captain H. Broadhead, commanding the reserve at the port. The ship drew 14ft. 9in. of water forward, and 15ft. 8in. aft, on getting under weigh. The wind was moderate from S.W., but squally at times. Six runs were first made at the measured mile with the following consecutive results in knots:—8·090, 8·651, 8·911, 8·275, 9·350, 7·610. The mean speed of the six runs was 8·652 knots. At half boiler power four runs over the mile gave 5·769, 5·042, 4·748, 6·081. The

mean speed of the four runs was 5·148 knots. In testing the engines to ascertain the time in which they could be worked, in obedience to a transmitted order, they were stopped dead in 11 seconds from full speed, from the time of moving the telegraph handle on the bridge; started ahead in 13 seconds, and astern in nine seconds.

NAVAL APPOINTMENTS.—The following appointments have taken place since our last:—J. Campbell, supernumerary in the *Asia*, promoted to First-class Assist. Engineer; H. B. Fabian, Engineer, W. E. Grigg, and G. Anderson, Assist. Engineers to the *Royalist*; F. W. Sutton, Engineer, to the *Indus*, as supernumerary; O. Jones, Chief Engineer, to the *Liverpool*; T. H. Punshon, promoted to Chief Engineer, and re-appointed to the *Chanticleer*; O. L. Carlisle, W. Curtin, and C. Bead, promoted to Chief Engineers, and discharged to half-pay; T. M'Farlane and P. Foulis, of the *Scout*, to be First-class Assist. Engineers; G. Rigby, First-class Assist. Engineer to the *Pelorus*; J. Slater, of the *Curacoa*, G. T. Ludlow, of the *Himalaya*, J. Pickles and J. Adams, of the *Asia*; J. Bnehart, of the *Cumberland*, F. T. Russell, of the *Indus*, T. M. Thompson, of the *Blenheim*, for the *Charon*; Geo. A. Moses, of the *Geyser*, and J. M'Garahan, of the *Dee*, promoted to be First-class Assist. Engineers; J. Bell (b), of the *Challenger*, S. T. Sugden, of the *Wanderer*, and L. P. Lewis, of the *Hecate*, promoted to be acting First-class Assist. Engineers; C. Ieely, Chief Engineer, to the *Cumberland*, for the *Caledonia*; J. Rose, Assist. Engineer, to the *Satellite*; J. Caspall, Assist. Engineer, to the *Stromboli*; T. M'Intosh, Assist. Engineer, to the *Alecto*; J. Grant, Assist. Engineer, to the *Triton*; R. G. Foster, Assist. Engineer, to the *Doterel*; W. E. Shingleton, Assist. Engineer, to the *Doterel*; A. M. Brumage, Assist. Engineer, to the *Victory*, for the *Sprightly*; G. Bain, Assist. Engineer, to the *Asia*, as supernumerary from the date of his arrival in England; J. Weir, Engineer, and J. G. Boyd and J. Murray, Assist. Engineers to the *Wasp*; J. B. Liddell, in the *Shearwater*, promoted to Acting Engineer.

MILITARY ENGINEERING.

TESTING ARMOUR PLATES AT PORTSMOUTH.—Some experiments at armour-plates took place on the 14th ult., at Portsmouth, and resulted in favour of the plates over the gun. The plates were bolted on the sides of the *Monarch* target ship in the ordinary manner, with 2-inch bolts, and were fired at with the 95 cwt. 68-pounder gun, at a distance of 200 yards. There were four plates, comprising one 4½in. plate from the Thames Iron-works and Shipbuilding Company for the *Minotaur*; one 4½in. plate from Messrs. John Brown and Co., of the Atlas Works, Sheffield, for the *Ocean*, and one 5½in. plate from the same firm, as an experimental plate, being made from Arcadian charcoal iron; one 5½in. plate, and one 4½in. plate from Messrs. Cammell and Co., of the Cyclops Works, Sheffield. Messrs. Brown's Arcadian iron plate received nine shots, one of which struck the right lower corner, and broke a piece off 16in. in length by 15in. in width. There were three other slight cracks, but the plate was not materially injured except in its broken corner, and where the backing also was afterwards found to be deficient. The metal, however, with which Messrs. Brown manufacture their own plates is undoubtedly superior to the Arcadian iron plate, the latter being apparently too hard for the manufacture of armour-plates of the first-class. The Thames Company's plate for the *Minotaur*, hammered, was the smallest of the four, but was one of superior manufacture and metal. Like Messrs. Brown's Arcadian plate, it was severely damaged on one of its corners by shot, and, the iron being there unsupported, necessarily gave way. The two plates sent in as test plates by Messrs. Cammell, of Sheffield, were "rolled," and gained for their manufacturers a position never before surpassed by any other plates on their first trial as test plates. The 5½in. plate, in its left centre, received six shots in a space measuring 18in. horizontally and 2ft. 10in. vertically. Over this space and through the indents of the shot marks there was nothing beyond three slight surface cracks. The plate received 11 shots in all. The 4½in. received 8 shots, and was possibly one shade inferior in quality to the 5½in. The metal of these two plates, as well as that of Messrs. Brown's 4½in., was beautifully fibrous. At the conclusion of the trials of the four plates several shots were fired at a French manufactured 4½in. plate that was bolted on to the target ship's side with Arcadian iron bolts. One of these shots struck the French plate in a comparatively uninjured part, and penetrated clear through into the ship's side, presenting a contrast to the stubborn resistance offered to the shot by the two English 4½in. plates that had but just been through their trial.

MR. PARSONS'S BREECH-LOADING 6-POUNDER underwent, on the 16th ult., a final trial at the proof-butt in the Royal Arsenal, by firing 100 rounds. The entire test occupied 52½ minutes, including a delay which took place at the sixth round. The ninety-four rounds fired from that time were completed in 42 minutes, or one round in 30 seconds. Although, from the rapid firing, the gun at its termination was so hot that the hand could not touch it, the breech action worked with perfect freedom, and maintained the breech quite gas tight. Mr. Parsons suggests the adaptation of his plan to guns of large calibre, as by it the sphere that serves the place of the vent-piece can be made of any size and strength necessary, as it has not to be lifted out of its place in the operation of loading. In a 110-pounder it may be made 900lbs. weight, and it will have corresponding strength.

RUSSIAN FORTIFICATIONS AND ORDNANCE.—Cronstadt is being strengthened under the superintendence of General Todleben and General Zareva, by placing the old forts in a better state of defence, and at many points covering up the masonry by earthworks. On the main island of Cronstadt, seaward, large earthworks are being thrown up, some of which are nearly finished. From the sea they will be scarcely visible, and they not only enfilade the channel, but some of them, being connected by parallels one with another, will be able to hold guns to take in reverse any ships which may run the gauntlet of their fire and that of the forts. Some of these earthworks, more exposed than others, are to be covered with 7½-inch plates, placed on an angle of 45 deg., and curved over the top, so as to form a cover from vertical fire, and at the same time obviate the necessity of having bolts or any other fastenings to retain the plates in position. The embrasures will be closed immediately the gun is fired by a slide of 11-inch iron, or by a drop door. The guns to be placed in these iron-clad and other earthworks are to be 9-inch rifled cast steel, carrying a 300lb. rifled shot, or a 250lb shell, 22in. long. For the protection of the granite forts, enormous supplies of earth and fascines are placed at different points. To provide further against the possibility of a fleet passing up to the back of Cronstadt by the south channel, about 300 lighters, laden with stones, have been sunk, so that now in no part is there more than four feet of water. Supposing a possibility of some hostile fleet passing the outer forts and earthworks they are prepared to lay 300 infernal machines in the channel, each of which will contain 70lb. of powder, and explode by a slight touch from a vessel passing over. Yet, still further, the enemy, presuming to have passed Cronstadt, and arrived some ten miles up, to the head of the bay, and wishing to pass the bar and enter the Neva here are fresh earthworks thrown up, which will be capable of mounting, in all, about 90 guns of the largest calibre, and enfilade the entrance to the river at a point where it is about 3000ft. wide. A supply of infernal machines is also to be kept ready to sink in the narrow channel of the bar. Another means of defence is also in course of preparation—a submarine boat of colossal dimensions, in the construction of which about 200 tons of iron and steel are to be used. This boat, it is stated, is to have engines worked by compressed air, to have a very strong beak, with provision for attaching large cylinders charged with powder to the bottoms of vessels, to be fired by electricity. The parties navigating the vessel will see what they are doing by means of bulls'-eyes, and they will be able to regulate the depth at which they swim, keeping quite close to the surface. The Emperor has approved of the plans, and some months since signed the decree appropriating about £27,000—say, 175,000 silver roubles—for this monster. By the 1st of June, 1864, the Marine Department expects to have at Cronstadt sixteen iron-clad vessels. There will be four vessels of larger size, all in many respects alike, including the *Pervenetz*, built in England, and which is receiving her armament and being finished off at Cronstadt. The second is building in St. Petersburgh, under contract, by Messrs. Mitchell, of Newcastle. All her armour-plates are on the spot, from Messrs. John Brown and Co.'s works, and she should be ready at the time named, and is to be called "Ne Tron Menya" (Touch me not). The third is building in St. Petersburgh by Messrs. Semenikoff and Politika, and progresses fast towards completion. Her armour-plates are also supplied by Messrs. John Brown and Co. The fourth is building by the Marine Department in the new Admiralty-yard, and her armour-plates are also from the same firm. The general dimensions of these vessels are as follows:—Length over all, about 220ft.; breadth, 53ft.; depth, 27ft.; builder's measurement, 2800 tons; the armament is not exactly settled, but will be rifled guns of heavy calibre. The remaining 12 vessels are all *Monitors*, but only one will have solid armour-plates, supplied by Messrs. Beale, and building by Messrs. Mitchell. She is from Capt. Cole's design, and very nearly a facsimile of the Danish vessel *Rolf Krake*, built in this country, particulars of which recently appeared in THE ARTIZAN. Her length is 175ft. between perpendiculars; breadth, 38ft.; depth, 14ft.; tonnage (b.m.) 1250. The remaining 11 vessels are building by Messrs. Carr and Macpherson, two; Semenikoff and Co., two; Kondraftzott, two; and the Government, five. They are to be clad with four and five one-inch plates, rolled in long lengths, following the American plan. The towers are to be of 11 one-inch plates bolted together, although a question has just arisen whether it would not be advisable to tap them through and through, and by that means strengthen them. The covering of these vessels with 1in. plates results partly from the haste with which the resolution to build was taken, and partly from the want of machinery in Russia to roll heavier plates. Great exertions are being made to obtain the requisite quantity of guns, with suitable ammunition, for all the forts, earthworks, and ships. The large rifled cast-steel guns which they are obtaining from Krupp, and which they will shortly commence making themselves in St. Petersburgh, are good, and the smaller sized cast-steel guns which are being produced rapidly in the Ural, and also in Pootieloff's works in St. Petersburgh, on Aboukoff's system, are found to be a great step in advance. They are not, perhaps, all that could be desired; yet they sustain a large amount of work, and their defects seem to arise from a want of hammer power, which want will be shortly supplied. Guns are now being produced in about a dozen factories, working night and day. Its production will be solid cast-steel guns, from the six-pounder to the eleven inch gun, which latter is to fire a 500lb. shell. To provide the necessary shot and shell for these guns all the foundries around St. Petersburgh have orders varying from 15,000 to 50,000 each. All the shot and shell from 12-pounders upwards are for rifled guns. The shot are from 2 to 2½ diameter, are round-nosed, and are provided with soft metal bearings to fit the grooves of the guns. The production of steel shell of the same description is also increasing fast, and great exertions are being made to deliver large supplies. Round hammered steel shot are also being prepared to suit the naval 60-pounder gun. One firm alone has in hand 30,000 of these. The land artillery forces are also adopting the steel guns for their service, and find them well adapted by their lightness. A gun of the same calibre is about one-third lighter than a brass gun.

EXPERIMENTS AT SHOEBURYNESS.—TRIAL OF THE ARMSTRONG MONSTER GUN.—A preliminary trial of Sir William Armstrong's monster gun, lately manufactured at Elswick for the War Department, was made on the 19th ult., at Shoeburyness. This gun weighs over 22 tons, and is mounted on an ordinary gun carriage. Its length over all is 15ft., that of the bore being 12ft. Its internal diameter is 13·3in., and it is rifled on the "shunting" principle. The grooves are 10 in number, and turn once in 65 calibres. The thickness of the walls of the gun at the breech is 20·85in., the total diameter at the trunnions being 55in. It carries a conical cast-iron hollow-headed shot, weighing 510lb., or a shell of ordinary construction weighing 600lb., and capable of containing a bursting charge of no less than 40lb. of powder. The charge used with shot was 70lb., with shell 60lb. The conical cast-iron hollow-headed shot first fired measured nearly 30in. in length, by 13·3in. in diameter. The shot is first placed in a cradle and lifted to the mouth of the gun by means of movable shear legs provided with blocks and pulleys. The cradle hinges on to a couple of hooks on the mouth of the piece, and holds the ponderous shot in the proper position for being rammed home. The gun was given one degree of elevation. The first shot struck the sand at about 700 yards from the shore, leaping and dashing onward, ricochetting five or six times, and finally burying itself near the 4000 yards' target. An attentive examination of the gun then proved that not the slightest injury had been sustained by it in any part. Two more shots were then fired at the same elevation, the second and third reports being apparently rather less loud than the first. The next three rounds were fired at an elevation of 2 deg., after which followed three at 5 deg., and three at 10 deg. Three dead shells weighing 600lb. each were then fired with charges of 60lb., a 300lb. round shot with a charge of 70lb., completing the day's experiments. The following are the tabulated results:—

Round.	Charge.	Shot or Shell.	Range.	Lateral Deviation.	Elevation of Gun.
	lb.		Yds.		Deg.
1	70	510lb. shot.	718	1 yd. left	1
2	70	"	785	1·5 yd. left	1
3	70	"	789	0	1
4	70	"	1160	1 2·5 yds. left	2
5	70	"	1148	1·5 yd. left	2
6	70	"	1184	0	2
7	70	"	2400	4 yds. right	5
8	70	"	2338	2·5 yds. left	5
9	70	"	2308	0	5
10	70	"	4080	2 yds. right	10
11	70	"	4176	0	10
12	70	"	4187	4 yds. left	10
13	60	600lb. shell.	1880	2 yds. left	10
14	60	"	1808	3 3·5 yds. left	10
15	60	"	...	...	10
16	70	300lb. round shot	...	...	10

Up to the sixth round the initial velocity was taken by Captain Noble with the very ingenious electro-ballistic apparatus invented by Major Navez, of the Belgian army. The mean initial velocity as determined by this delicate instrument was found to be as nearly as possible 1200ft. in a second. It will be noticed in the above table that no ranges or lateral deviations are given for the last two rounds. This was merely on account of the tide having covered the spots where the shots touched before they could be measured.

EXPERIMENTS AT SHOEBURYNESS.—TRIAL OF THOMAS'S GUN.—The 9-inch muzzle-loading gun made at the Royal Gun Factories, Woolwich, and rifled on the plan proposed by Mr. Lynall Thomas, was tried at Shoeburyness, on the 20th ult. This gun, which carries a 300lb. shot, closely resembles an ordinary muzzle-loading Armstrong in outward appearance, the muzzle, however, being more prolonged. Mr. Lynall Thomas's invention consists in substituting a series of ribs for the usual grooves. The shot are made with grooves coated with soft alloy to fit the ribs of the gun, and are similar in form to those

used in the Armstrong, but appear to be slightly longer. The "shunt" principle is not employed by Mr. Lynall Thomas. To test the range and accuracy of the gun 10 rounds of cast-iron shot were fired from it at 2 deg. elevation, 10 at 5 deg., and 10 at 10 deg., the charge being 40lb. in every instance. The initial velocity of the projectiles was ascertained in the case of those fired at 2 deg. elevation by Major Navez's electro-ballistic apparatus. It was intended to repeat the experiments with cast-iron shells, but Mr. Thomas objected to those upon the ground as being too long; a similar objection to the shot was also urged by him during the course of the experiments. He also stated that the ribs were finished too abruptly at the spot where they join the chamber of the gun. The following table will show that both the velocity and range of the shots fired are very unequal. This is accounted for by Mr. Thomas by the facts mentioned above, and by the powder not being always rammed home to exactly the same mark. Whether the latter circumstance has any weight or not is doubtful, as in other rifled guns the ramming home of the powder to the same place within a few inches does not seem to affect materially the flight of the shot. Notes were taken at each round of the exact depth to which the charge was rammed; it will, therefore, be seen hereafter whether this circumstance has any influence on the projectile or not:—

At 2 deg.			At 5 deg.		At 10 deg.	
No. of round.	Initial velocity.	Range.	No. of round.	Range.	No. of round.	Range.
		Yds.		Yds.		Yds.
1	1075 feet	948	11	2008	21	3635
2		928	12	1883	22	3768
3	to	955	13	2073	23	3775
4		1029	14	1957	24	3795
5	1217 feet	999	15	2082	25	3921
6		958	16	2142	26	4006
7	per	928	17	2123	27	3569
8		939	18	1945	28	3863
9	second.	971	19	2161	29	3680
10		1092	20	2095	30	3791

The table shows that at 2 deg. elevation the difference in the range is 164 yards; at 5 deg. 278 yards; and at 10 deg., 437 yards—all large numbers compared with those obtained in experiments with other rifled guns at similar elevations. The difference in the velocities is also large, being 142ft. per second.

English *v.* Swedish Iron.—Experiments have recently been made at the fortress of Carlberg, in Sweden, upon the respective merits of armour-plates made in England, France, and Sweden. Messrs. John Brown and Co., of Sheffield, sent two plates, one 12ft. by 2ft. 6in., and one 6ft. by 3ft. 8in. Messrs. Petin, Gaudet, and Co., of Lyons, sent two plates, each of 7ft. 6in. by 3ft. 3in. The Montala Ironworks Company, of Sweden, sent two plates of 12ft. by 2ft. 6in., and one 6ft. by 3ft. 8in. All the plates were of 4½in. thickness, and then bolted to a teak target backed with iron plating, and supported by a massive stone pier. The two upper plates in the target were the French, and each was secured by 11 bolts. The next plate below was the longest, Swedish, and this was secured by 29 bolts. Below this was a tier of two short plates, one Swedish and one English, secured, like the Swedish, by 29 bolts. Each plate received six shots from the ordinary 68-pounder naval gun. The French and Swedish plates broke to pieces, and the English plates remained uninjured and free from cracks. The shots used were of Swedish iron, and of great toughness as compared with the shots used in the English service—the core or centre of the shot, after striking, being of double the weight of the core of the English shot.

Experiments with a new Suspension-bridge.—Some trials have recently taken place on the Royal Engineers' field-works, Chatham, for the purpose of testing a new description of suspension-bridge, for military purposes, the invention of Serjeant-major J. Jones, Royal Engineers. The bridge on which the experiments were made was formed of the galvanised iron bands with which the new description of iron gabions now in use in the service are formed. These bands, which are about 3in. in width, and the thirtieth part of an inch in thickness, were joined together at the end, by means of a button and eye; and, notwithstanding the apparent slenderness of the material, bore an enormous weight. Eight widths of the iron bands, each four bands thick, formed the "chains" of the suspension-bridge, and on these were laid the chesses, used in pontooning, which served as the floor of the bridge, the whole being steadied by means of guy ropes, fastened to stakes, answering to anchors in a river. With these materials a bridge having the span of 130ft. was formed by thirty Sappers and Miners in six hours. A battery of mounted field artillery was marched across with the greatest ease, the bridge having only a very slight oscillation. A body of about thirty Royal Engineers were next marched across, in step, and this was the greatest strain to which the structure could be put. Notwithstanding this, however, the only perceptible defect was the great oscillation of the bridge, which ultimately loosened one of the guide ropes.

STEAM SHIPPING.

The "Will o' the Wisp," iron paddle steamer, 600 tons, and 180 horse-power, was tried on the 7th ult., on the Clyde. The builders had engaged to carry 200 tons dead weight, at the speed of 17 miles an hour, under a considerable penalty, the owners engaging to pay a premium of the same amount if the vessel exceeded that speed. With the 200 tons dead weight the vessel accomplished the distance between the Cloch and Cumbrae Lights in 52 min. 11 sec., being over 18 miles an hour. The *Will o' the Wisp* was designed, built, and engined by Messrs. W. Simons and Co., London Works, Renfrew.

Steam Shipbuilding on the Clyde.—Messrs. W. Denny and Brothers, of Dumbarton, have completed a screw of 750 tons, built for the New Zealand trade. Messrs. W. Simons and Co., of Renfrew, have launched a paddle of 600 tons, named the *Will o' the Wisp*, which took the water with her engines on board; she has been purchased by a Liverpool firm for a trade where speed and strength are of the greatest importance. Messrs. Caird and Co., of Greenock, have launched a paddle named the *Lord Clyde*, built for the Glasgow and Dublin Steam Navigation Company, and intended to run as a consort to the *Lord Gough*. Messrs. Kirkpatrick, M'Intyre, and Co., of Port Glasgow, have completed the *Greyhound*, a screw, built for Mr. R. Little, of Greenock. She is 200ft. long, 23ft. beam, and 13ft. depth of hold, is flush decked, and is divided into seven water-tight compartments. She is being fitted with engines by Messrs. Caird and Co., of Greenock. Messrs. J. and G. Thomson, of Govan, have launched the *Pampero*, a screw of about 1000 tons register, built for London owners. Messrs. Tod and M'Gregor, of Patrick, have launched the *Caledonia*, a screw of 1360 tons, for Messrs. Handyside and Henderson's line of Quebec and Montreal steamers. The *Caledonia* is being fitted with a pair of direct acting engines. Messrs. Randolph, Elder, and Co., of Govan, have completed the *Quito*, a paddle, of 1400 tons, built for the Pacific Steam Navigation Company, of the following dimensions.—Length between perpendiculars, 266ft.; breadth between paddle boxes, 32ft. 6in.; depth to spar deck, 20ft.; ditto to awning deck, 28ft. The engines of the *Quito* are on Messrs. Randolph, Elder, and Co.'s patent double-cylinder surface condensing and steam-superheating principle; they are the twelfth pair constructed by the firm for the Pacific Steam Navigation Company, and are of 400 horse-power. As coal costs from £3 to £4 per ton in the Pacific, special attention has been devoted to the economising of combustible. Messrs. Randolph, Elder, and Co. have secured an additional shipbuilding yard at Fairfield, in consequence of their increasing business. Messrs. Blackwood and Gordon have launched at Port Glasgow a screw of 500 tons, named the *Wellington*, and intended for the passenger trade of the New Zealand coast line. The *Wellington* is being fitted with engines of 90 horse-power. Messrs. J. and G. Thomson, of Govan, have launched a screw of 700 tons and 180 horse-power for the Tasmanian Steam Navigation Company. She has been named the *Southern Cross*. Messrs. Barclay, Curle, and Co., of Stobcross, have launched a screw named the *Albatross*, built for Messrs Cowan and Co., of Edinburgh, and intended for the Australian coasting trade. The *Albatross*, which will be fitted with engines of 125-horse power, is 210ft. in length, 27ft. in breadth, and 14ft. 6in. in depth; her burden is 750 tons. Mr. T. B. Seath has launched a screw of 150 tons, named the *Protector*, and now being fitted with engines on Mr. Seath's patent by Messrs. A. Campbell and Son. Messrs. Aitken and Mansell, of Whitewich, have launched a paddle of 600 tons named the *Arrow*. She is being fitted with her machinery at Finnieston-quay, by Messrs. J. Aitken and Co., Cranston-hill, and will shortly leave for Nassau. Messrs. W. Denny and Brothers, of Dumbarton, have purchased a large field situated between the Castle-road and the Leven, for the purpose of converting it into a shipbuilding yard. The Cunard Company have just completed a contract with Messrs. J. and J. Thomson for the construction of three large screws, to be named respectively the *Java*, the *Aleppo*, and the *Trinidada*; one is intended for service on the Atlantic mail line and two for the Mediterranean.

The "Wasp," screw corvette, 974 tons and 100 nominal horse-power, underwent her official trial at the measured mile at Stoke's Bay, on the 13th ult. The ship's draught of water was 13ft. 8in. forward, and 14ft. 2in. aft., with an immersion of the screw's upper edge of 7in. The screw, which is of the common pattern, with the leading corners cut, has a diameter of 11ft. 3in. and a pitch of 14ft. 10in. The mean speed of the *Wasp*, with full boiler power, was 8·176 knots, and with half boiler power 5·765 knots, the indicated horse-power being 280.

The "Far East," iron screw steamer, has been launched from the yard of Messrs. Dudgeon, at Millwall. The *Far East* in intended for the China trade, and her principal dimensions are:—Length between perpendiculars, 227ft.; length of keel, 210ft.; breadth of beam, 34ft.; depth moulded, 22ft.; depth of hold, 20ft. 6in.; depth of load water line, 17ft.; displacement of hull, 2200; builder's measurement, 1270 tons. She is fitted with engines of 150 horse-power nominal, which drive a two bladed lifting screw, under each quarter. The engines have annular combined cylinders, the diameter of the high pressure cylinder being 24in., and of the expansive cylinder 50in., with a stroke of piston of 2ft. The screws have each a diameter of 8ft. 2in., and a pitch of 16ft. The two boilers have each six furnaces, with 109 square feet of fire-bar surface, and a tube surface of 1883ft. The shafting of the screws project through a wrought-iron tube of great strength, which is bolted on to a false iron bulkhead, clear altogether of the ship frame. This tube at its outer end is connected with a massive wrought-iron slide, which guides the screw to the well when being lifted, or to the shafting when being lowered. The ordinary "cheese-coupling," by which the screw is connected with the shafting, is superseded in the shaft by a square head at the end, which fits into a corresponding recess in the boss of the screw, which is connected by a thrust block fixed on a sliding rest. The screws are lifted by a worm and barrel.

TELEGRAPHIC ENGINEERING.

The Submarine Telegraph across the Bristol Channel.—The British and Magnetic Telegraph Company have successfully laid a submarine cable across the Bristol Channel at New Passage. This cable, which contains several wires, is intended to enable the Bristol and South Wales Union Railway Company to communicate from the Gloucestershire to the Monmouthshire shore, and *vice versâ*, the Telegraph Company laying down additional wires, in order to afford greater facilities for the increasing business requirements between South Wales and Bristol.

RAILWAYS.

A Safety Locomotive for Sharp Curves.—Mr. Cross, the engineer of the St. Helen's Railway, Lancashire, has been for some time occupied with the construction at the company's works of a new class of engine, the result of which in practice so well corresponds to sound theory that it is likely to exercise a material influence on the structure of new railways, by the substitution of sharp curves for tunnels in mountain regions, and also for facilitating junctions between lines and the entrance into cities. The St. Helen's line, running through a hilly mineral district, is a remarkable sample of sharp curves and gradients. In a length of about 30 miles it has a constant succession of curves, varying from 500ft. radius down to 170, and it has gradients from one in 85 to one in 35, and it has, moreover, a large number of "points and crossings" opening into the various mineral deposits. This line has been usually worked by short engines on six wheels with four coupled wheels as drivers, and connected to separate tenders for the supply of fuel and water, the length of the wheel base of the engines being about 12ft. Even this comparatively short length of engine was disadvantageous on curves, involving much impedimental friction; and a still greater disadvantage was that tender engines are only adapted to run safely with the tender behind, and in the working and shunting the loss of time and labour, and expense, was considerable. For this reason Mr. Cross set about the construction of an engine that should be capable of running freely and without impedimental friction in a straight line, and either end foremost, and also pass with free rolling movement round curves of as sharp a curve as a radius of 132ft., or two chains. The engine is on eight wheels, covering a base of 22ft. in length, and the length of a solid frame resting on it 32ft. The four central wheels have their axles passing through, before, and behind the engine fire-box as usual, the axles being about eight feet apart. It is obvious that so long an engine could scarcely pass round curves at all, even at any cost of friction, with the ordinary construction of wheels and axles. The difficulty is obviated by a very simple process. The four central wheels have their axles rigidly parallel to each other. Consequently, in the ordinary mode of construction, they could not move in a curved line without a great amount of impedimental friction. This friction is avoided by a simple process of construction. The wheel tires are applied on hoop springs of elastic steel placed between the wheel and tire. On these springs the tires can slip or revolve without sliding on the rails, and thus the revolutions of the tires are adjusted to the varying length of the rails on curves by self-action. This sliding of the wheels on the tires is not found in any way to impede the tractive power of the engine, but the contrary. The extreme wheels at either end have their tires applied in the same mode, but another movement is also supplied—the axles have very long bearings, and the boxes in which they run, instead of being parallel to the axles, are formed in curved lines struck from central points, and are permitted to move in this curvature through the hornplates and axle-guides beneath the spring shoes. The result of this is that the wheels and flanges are free to follow the course of the rails both on the straight line and on curves, with the very important advantage in point of safety that the extreme axles on curves always point truly to the centre of the curve, and consequently are square to the rails, even though the curve may be in the form of an S, requiring the axles to radiate in opposite directions. There is, therefore, no tendency in the wheels to escape from the rails either on curves or straight lines, and, though adapted to such small radii, the great

length of the frame governs and controls the action of the pistons on the cranks, and prevents both vertical and lateral oscillation, while the wheels are deprived of their vicious irregularity by the removal of the costly and dangerous friction, and the wear of tires and rails is reduced to the minimum.

CHEAP RAILWAYS IN THE NORTH OF SCOTLAND.—Sir J. D. Elphinstone, in an account of the great length of railways made in the north of Scotland at a cheap rate, says—"For the last fifteen years I have been engaged in carrying out a system of railways to supply the wants of the counties of Aberdeen and Banff, which is now almost completed. The whole will extend, in main line and branches, to above 190 miles, of which 180 miles are open and in full operation, completely exhausting the wants of these counties." Among them is "the main line from Aberdeen to Keith, forming part of the through line from that city to Inverness, 53½ miles: it is double for seven miles; from there, land taken and over bridges constructed for a double line, two long viaducts over the rivers Don and Deveron, heavy rock cuttings, expensive town property in the vicinity of Aberdeen, and £85,000 preliminary (Parliamentary) expenses, cost £14,000 per mile." There is also the "Strathspey Railway, 32½ miles,—two expensive crossings of the River Spey, one of the largest, and certainly the wildest, river in Scotland; two of the Fiddoch, also a very unruly stream; a short tunnel, heavy rock cuttings, and other works,—£7500 per mile. This railway, considering the works, is probably the cheapest line that has ever been executed." The other lines range from £6500 to £9000 a mile. "The majority of the works on these lines are of granite, most solid and substantial."

CITY TRAFFIC.—The Ludgate-hill railway station will be placed between Bridge-street and Earl-street, Blackfriars, and its carriage approach will be from Earl-street. The latter thoroughfare is about to be widened by the Board of Works, and to be continued in a direct course towards Cannon-street, whereby there will then not only be an easy and brief cut towards London Bridge and the eastern parts of the City, but the great thoroughfare up Ludgate-hill, round St. Paul's, and down Cheapside, will be considerably relieved. The line of railway from Ludgate-hill station will run in a north-easterly direction, passing under Skinner-street, Snow-hill, to a junction with the Metropolitan Railway near Charles-street, Smithfield; and there will also be a spur line from it, in a still more easterly course, to meet the line of the Metropolitan Railway Extension to Finsbury, at a point near the northern extremity of King-street, Smithfield.

RAILWAY ACCIDENTS.

ACCIDENT ON THE LONDON AND NORTH-WESTERN RAILWAY.—An accident, unattended with serious consequences, happened on the 3rd ult., at Weedon, on the London and North-Western Railway. As the goods train was being shunted from one line of rails to another the axle of one of the carriages broke. It then became impossible to remove the carriages quickly, and in the meantime a second goods train arrived, and came into collision with the carriages which blocked the way.

ACCIDENT ON THE GREAT EASTERN RAILWAY.—On the night of the 2nd ult., a collision occurred on this company's line between the goods depôt station at Brick-lane and the passenger station at Shoreditch. It appears that the engine attached to the 10.40 p.m. down goods train had moved out of the up siding line from the goods station a short distance up the main line, when it suddenly came into collision with the last up passenger train from Loughton, due at the Shoreditch station at 10.45. The engine of the Loughton train was thrown off the rails, with the guard's break van and two carriages, all of which were severely damaged and broken. There were few passengers in the train, but they were all severely shaken, and more or less contused.

BOILER EXPLOSIONS.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.—At the ordinary monthly meeting of this association, held on October 27th, 1863, the chief engineer presented his monthly report, of which the following is an abstract:—"During the past month there have been examined 390 engines and 440 boilers. Of the latter, 32 have been examined specially, 7 internally, 31 thoroughly, and 370 externally, in addition to which 2 of these boilers has been tested by hydraulic pressure. The following defects have been found in the boilers examined:—Fracture, 6 (1 dangerous); corrosion 18 (2 dangerous); safety valves out of order, 8; water gauges ditto, 19 (4 dangerous); pressure gauges ditto, 14 (1 dangerous); feed apparatus ditto, 5 (1 dangerous); blow-out apparatus, 43; fusible plugs ditto, 4; furnaces out of shape, 5 (2 dangerous); over-pressure, 3 (3 dangerous); blistered plates, 2. Total, 127 (14 dangerous). Boilers without glass water gauges, 11; without pressure gauges, 2; without blow-out apparatus, 13; without back pressure valves, 43. The three furnaces reported above as out of shape, all became so from overheating, consequent upon shortness of water, the injury in each case being observed for the first time, on setting to work in the morning, after the boiler had been standing during the night with the fires banked up, while two of the cases of injury were first observed on a Monday. Each of the boilers had but a single glass water gauge, two of which were of the pillar construction, while all the boilers were fitted with fusible plugs, which proved inoperative in every instance. One of the boilers was fitted with a fusible plug in each furnace, both the crowns of which came down; the second was fitted with a fusible plug in the right hand furnace only, and that was the one injured; while the third was fitted with a fusible plug in the left hand fire box, and the right hand was the one injured. But in neither case did the fusible metal melt or give any sign. There are several ways in which the water supply may run short in a boiler left standing for the night with the fire banked up, all of which should be guarded against. Where there is only a single glass gauge, the attendant may be deceived as to the actual amount of water in the boiler; and thus the supply be left short overnight, unawares. It is well, therefore, to add a duplicate gauge, so that one may act as a check upon the accuracy of the other; this would frequently prevent mistake. Again, leakage may occur at the feed back-pressure valve, or at the blow-out tap, either from their being in bad company or imperfectly closed. Enginemen are not sufficiently alive to the importance of examining these as a precaution, but leave them untouched until proved to be actually defective, whereas the feed back-pressure valve should be frequently taken out, and its free action ascertained; while the blow-out tap also should be examined, the plug cleaned and greased, as well as ground up, if necessary. A considerable safeguard also to furnace crowns would be found in a low water safety valve, which lets off the pressure of the steam on a deficiency of water occurring within the boiler. It may be true that it would not necessarily prevent the furnace crowns from becoming over-heated, since the fire would go on burning if left to itself, after the water supply had run short; but as the valve would not admit of any accumulation of steam, the injury would be confined to the plates over the fire; unless, by excessive carelessness, the attendant should let in the water and get up steam in the morning without observing the distorted furnace crown. Such, however, could not occur without the most culpable blindness, against which it is impossible to provide. Five boilers, not under the inspection of this Association, have exploded during the past month, from which eight persons have been killed and four others injured. Three of the boilers have been personally examined since the explosion. No. 33 explosion. The particulars of this explosion may be briefly told. The boiler, which was not under the inspection of this Association, was the outer one of the three working side by side and connected together, all of them being of the balloon or haystack class. Each of these boilers was of large diameter, the one in question being about 18ft. at the base, the sides swelling to a [illegible] larger diameter at the springing of the hemispherical domed top. The bottom, which was arched, but had no stays to tie it to the crown, was [illegible] by the plates being bent, and was seated upon a circular kerb of brickwork. Each of the boilers was fitted with a single safety valve, of rather a rough description, while it was stated that the working pressure had not exceeded 5lb., but that the exploded boiler, which was twenty years old, had already been repaired several times. Immediately over the brickwork seating, the plates for some distance round the boiler had been seriously affected by external corrosion, and reduced in places to one-eighth of an inch in thickness. It was from this cause that the rent occurred, the rent running circumferentially for a distance of ten or twelve feet, parallel with the seating, and for the most part through the body of the plate. A portion of the bottom was blown down into the ashpit, where it remained, the rest of the shell flying to a distance of about 70ft. across a public road adjoining, and carrying away a portion of the boiler shed in its flight. The engineer, as well as another man lying near to the boiler at the time, were both scalded, the latter dying shortly after in consequence. No. 35 explosion, from which one person was killed, arose from the collapse of the internal flue of a plain Cornish boiler, which was not under the inspection of this Association. The diameter of the shell was about 5ft. 6in., that of the flue 3ft., the length of both 28ft., the thickness of the plates generally three-eighths of an inch, but in the flues barely as much, while the steam pressure was 45lb. per square inch. The collapse had extended from one end of the flue to the other, the portion over the fire being the least affected, while the remainder behind the bridge was completely flattened down. The boiler had not, however, stirred from its seat, or broken a steam pipe joint, and all that was needed to resume work with the other two boilers, to which this was connected, was to close the junction valve. A rupture in an externally-fired boiler would have led to the dislocation of the whole series. The cause of the explosion in question was, viz., weakness of the flue. No flue of such dimensions as those just given can be safely worked with steam of a pressure of 45lb. on the square inch, unless strengthened either with hoops or flanged seams, or stayed in some other suitable manner. It may be true, however, that some such flues, though unstayed, are working, and have done so for years with steam of an equal or even a greater pressure than the above; still they are continuing to do so only at a risk, and their past immunity from collapse is no security against its occurrence in the future. Some flues gradually work themselves out of the circular shape, and thus become considerably weakened; while all should be placed beyond the suspicion of danger, especially as this can be done at so trifling an expense. No. 37 explosion occurred to a Cornish boiler with a single flue, internally fired, and not under the inspection of this Association. No one was injured, the explosion occurring during the dinner hour, when the men usually working near it were all absent. The boiler was set on two side walls. It was 23ft. long; its diameter in the shell was 6ft.; and in the furnace 3ft. 6in., which was reduced behind the fire bridge; while the thickness of the plates was seven-sixteenths of an inch. The cause of the explosion was external corrosion, the plates having been so eaten away as to be reduced to one-sixteenth of an inch in thickness. Two complete belts, the entire circumference of the boiler, and a plate wide, had severed themselves from it; while a third, which had rent in a somewhat spiral direction, and considerably overlapped a single circumference, lay opened out, and still attached to the shell.

AN ASTRONOMER ON BOILER EXPLOSIONS, &c.—We quote the following from a recent number of the *Scientific American*:—A somewhat confused account is given of some experiments made with a boiler, and conclusions are drawn as to the comparative destructive powers of water heated under a pressure of 60lb. to the inch, and gunpowder. The conclusions are entirely irrelevant to the question of boiler explosions, for the destructive effect of an expansive agent is in proportion to the suddenness of its action as well as its expansibility, and yet not a particle of information is given by the Astronomer Royal as to the time occupied by the heated water in giving off its vapour so as to compare it with the instantaneous expansive action of ignited gunpowder. We can take the same materials of which a charge of gunpowder is made, and by simply altering their form into coarse or fine grain, a gun may be shattered to pieces by instantaneous ignition of the charge, or fired without danger, owing to the slower ignition of the charge. And the same law holds equally good in the case of heated water generating steam. The evaporation of heated water into steam, when relieved of pressure, goes on very slowly compared with the instantaneous expansion of ignited gunpowder; and its disruptive effect are low in proportion. A pound of anthracite coal under combustion will develope more power than a pound of gunpowder, but it will not produce the same disruptive effects; because its combustion was more slow, and the expansive gases resulting from it do not therefore generate pressure so instantaneously. The statements contained in the extracts from the paper of Professor Airy seem to confute the conclusions. It is stated that the disruptive results witnessed in boiler explosions are not due to the initial pressure of the steam, but to the quantity of highly heated water in a boiler, generating a great quantity of steam, when relieved from pressure, such as by a rupture. The quantity of water converted into steam, when relieved of pressure, is given in one case, and yet it is admitted that such steam is of a lower pressure than that which first escapes and lowers the pressure in a boiler by a rupture. The cause of a rupture in any boiler is due to the pressure being greater than the part that fails can withstand. Now supposing the pressure in a boiler is 60lb. on the inch, and that it is instantly lowered to 30lb. or 15lb., by a large quantity of steam suddenly escaping through a rupture, all the steam which is generated afterward from the heated water in the boiler is of the pressure under which it is generated. There can be no doubt about this. It therefore follows that if 60lb. pressure of steam only produced a rupture in the boiler, the 30lb. or 15lb. pressure of the steam afterwards generated from the water, cannot produce a greater disruptive effect, for a lesser cannot produce a greater result. The Astronomer Royal appears to have mistaken quantity of steam for intensity of pressure. Mr. Fletcher, Engineer of the Manchester Association for the Prevention of Boiler Explosions, stated some time since that he intended to undertake some experiments to test this theory of explosions. We trust his intentions will be carried out, and that William Fairbairn, F.R.S., may be associated with him in the undertaking. If the theory of boiler explosions above set forth is correct, then it is high time the engineering fraternity ceased to construct boilers with safety valves for the purpose of letting off steam and reducing its pressure, because such devices must produce the very results they are intended to obviate.

BOILER EXPLOSION AT GLASGOW.—On the 13th ult., a boiler explosion, accompanied with fatal results, occurred in the chemical works of Messrs. Charles Tennent and Co., St. Rollox, Glasgow. The portion of the establishment in which the accident took place is an extensive shed-like building, where the manganese recovery process is carried on. A good deal of machinery is employed in this portion of the works, and the engine which affords the necessary power is supplied with steam from a set of boilers placed within the building. The boilers, which are five in number, have been in use about three years, and seemed to be of the most substantial construction. At the time when the accident occurred only three of the boilers were in use. It was about a quarter to four o'clock when the men employed about the works and the men in the neighbourhood were startled by a pretty loud report, and presently those in the immediate vicinity found themselves enveloped in clouds of steam and exposed to streams or splashes of scalding water. When the catastrophe had partially subsided, and the steam had begun to clear away, the nature of the accident became apparent. It was discovered that the boiler had been lifted bodily a foot or two from its bed, and had settled down again on the ruins of the brickwork which had enclosed it. The brickwork at both ends was blown down and lay in two heaps of [illegible], and a considerable portion of that which had supported the west side of the boiler was also displaced. The boiler itself seemed externally to have sustained no damage, but on [illegible] inside it was found that the flue had been torn to pieces. Giving [illegible], the boiler had belched forth the boiling water, with which it was

charged, through the flue apertnres at hoth ends. At the north end, the scalding steam was arrested in its course hy the opposite wall of the firehole; while at the opposite extremity the wall of the kiln above referred to interposed an equally effective barrier to its passage.

BOILER EXPLOSION AT TODMORDEN.—On the 3rd ult. a boiler explosion took place at one of the three cotton-mills of Messrs. Ingham and Sons, on the side of the canal at Todmorden. The mill is a five-story stone building, with the engine-house and boilers at one end. It bad heen left standing idle for a few days, hut on the morning of the above date steam was got up for the purpose of starting, aud many of the workpeople were inside the mill. It is supposed that, through some oversight, the hoiler was not sufficiently filled with water, and some of tbe plates bad got nearly red-bot, when, the first stroke of the engine causing some cold water to be injected, an explosiou occurred. One end of the boiler was blown out to a distance of 30 yards, aud lodged against a wall. Tbe mill was at the same time filled with steam, and shaken so severely as to loosen the floors, cause the roof to fall in, and to become almost a wreck.

BOILER EXPLOSION AT GREENWICH.—On the morning of the 18th ult., a boiler explosion took place at the creosote and alum works of Mr. John Bethell, situate in Greenwich marshes, hy which the engineer was instantly killed and four other men were severely injured. The boiler was lifted from its position, and carried forward a distance of some 20 yards, and the fragments were thrown in all directions. The timbers of the long linc of shed in which the business was carried on took fire, and, notwithstanding the arrival of the Deptford floating engine and that of the parish, the buildiug was destroyed.

GAS SUPPLY.

GAS COALS OF GREAT BRITAIN.—The following is an extract from a table of analyses of various Scotch Cannels, made by Dr. Penny, of Glasgow, from which may he gathered some useful informatiou respecting the relative composition of these coals:—

Locality, or Name of Coal.	Specific gravity.	Volatile matters. Per cent.	Fixed carhon. Per ct.	Ash. Per ct.	Sulphur. Per ct.	Water. Per ct.	Coke. Per ct.
Roch Soles, 1851	1·448	53·7	4·9	38·8	1·6	1·0	43·7
Boghead, 1851*	1·160	71·06	7·10	21·2	0·24	0·4	28·3
Boghead, 1851†	1·218	62·7	9·25	26·5	0·35	1·2	35·75
Torbane Hill, 1853	1·189	67·11	10·52	21·0	0·32	1·05	31·52
Boghead, 1849	1·155	71·3	11·3	16·8	0·34	0·6	28·10
Battisville	1·201	64·35	12·6	22·2	0·25	0·6	34·8
Methill	1·300	49·23	17·57	29·7	...	3·5	47·27
Capeldrae	1·360	45·73	19·97	31·5	...	2·8	51·47
Wemyss	1·183	58·52	25·28	14·25	...	1·95	39·53
Lesmahago‡	1·199	56·23	36·7	4·3	0·55	2·22	41·00
Lesmahago‖	1·228	49·34	40·97	6·34	1·35	2·0	47·31
Knight's Wood	1·234	44·77	41·13	11·05	...	3·05	52·18
Cairnbroe	1·247	42·83	42·67	8·5	...	6·0	51·17
Kelvinside	1·231	40·17	53·42	1·9	0·21	4·3	55·32

* Brown. † Black. ‡ Auchinheatb. ‖ Southfield.

The following are the quantities of gas in cubic feet per ton obtained from the principal British gas coals:—

		Cubic feet per ton.
In SCOTLAND—	Boghead	15,000
	Lesmahago	13,500
	Capeldrae	14,400
	Arniston	13,600
	Ramsey	10,300
	Wemyss	14,300
In ENGLAND—	Pelton	11,000
	Pelton Cannel	11,500
	Leverson ditto	11,600
	Washington ditto	10,500
	Pelaw	11,000
	New Pelton	10,500
	Dean's Primrose	10,500
	Ponesfield	10,500
	Gosforth	10,000
	West Hartley	10,500
	Hasting's Hartley	10,300

PETROLEUM GAS.—A writer in the American *Gas Light Journal* observes that the laws governing the destructive distillation of petroleum and its distillates are the opposite to those so successfully applied to the manufacture of coal gas. They are as follows:—1st. Graduation in the application of the heat, in order to vapourise the oil only as fast as the means provided to convert the vapour formed into gas can so act upon it; otherwise there must be great waste of material.—2nd. As, on the one band, to convert vapour into gas requires its actual contact witb red-hot iron, and, on the other, such contact, if continued, again decomposes the gas (the cause of the carbonaceous deposit so often found in gas retorts, wbich comes from tbe destruction of gas, not vapour or tar, as many suppose), the apparatus must he so arranged as to compel tbe vapour in its passage out of the retort to come into contact with its red-hot surface, and wbile in such contact to travel so rapidly as to leave little or no time for the decomposition of gas. When treated according to these laws, petroleum will yield to the gallon 125ft. of gas, of surpassing richness, and there will be no clogging in the pipes or deposit in the retorts. But to make tbe manufacture profitable for gas companies, a third condition is required—to wit, dilution of the gas to secure its combustion without smoke, and enable it to be sold at the prices charged for coal gas. This condition is fulfilled by distilling the oil in connection with wood. The hydrogen thus obtained, while it dilutes the olefiant gas from the oil, also conserves it while the two gases are passing together over the red-hot surface of the retort. In truth, this process requires so little oil, most of the gases being made from the wood, that, perhaps, the proper classification of petroleum in the manufacture of gas is not as the basis of the process, but merely as the means of enriching hydrogen gas obtained from wood. He limits the material from which the hydrogen is to be obtained to wood, because tbe objections to tbe use of water for such a purpose are fatal, and wood alone affords a residuum of equal value with the coke obtained from coal, aud which hitherto has been regarded as its great safe-guard against competition. It appears that from each gallon of petroleum, or petroleum tar (which when treated with wood answers the same purpose as tbe oil), and 155ft. of hard wood, 300ft. of gas of equal illumiuating power with coal gas, and nearly two hushels of good clean charcoal (worth tbe cost of the wood) is produeed; tbe cost of the gas, consequently, beiug only that of the tar or oil used.

THE CORPORATION OF STOCKPORT have expressed their intention to reduce the price of their gas (24 candles), manufactured entirely from Wigan Cannel, on the 1st January next, from 5s. per 1000ft. beyond the horough limits, and 4s. 6d. per 1000ft. within the borough, to one uniform rate of 4s. per 1000ft., with a progressive scale of discounts, commencing on a quarterly consumption of 200,000 cuhic feet. Their engineer, Mr. Frederick Leslie, has extensively altered the plant and mains, having laid a 24-inch trunk main, and several miles of mains of all sizes during tbe past spring and summer season. Tbe Corporation propose next year to spend between £15,000 and £20,000 in new works and mains.

THE SURREY CONSUMERS' GAS COMPANY have declared a dividend of 7 per cent. for the last half-year, or 14 per cent. per annum, comprising 5 per cent. for the half-year and 2 per cent. on account of back dividends.

IN STOURBRIDGE, at a public meeting, it was resolved to request the local commissioners to erect new gas works for the town. The consumers appear to be willing to compromise the matter with the local gas company if the latter will consent to an uniform maximum price of 3s. 9d. per 1000 cuhic feet in the township, and 4s. 2d. out of it.

THE SHEFFIELD GAS COMPANY have declared a dividend of 10 per cent. per annum on class A shares, and 8 per cent. on class B.

THE ROTHERHAM GAS COMPANY have declared a dividend after the rate of 10 per cent. on A stock, 8 per cent. ou B stock and on D shares (so far as the latter are paid up), for the past half-year; and tbat half a year's arrear of dividend, at the rate of 2 per cent. (unpaid in former years), on A stock be also paid free from income-tax.

THE BRECON GAS COMPANY have resolved to reduce the price of their gas from 6s. to 5s. per 1000ft.

READING GAS WORKS.—The extensive alterations and additions that have been going on for some time at these works are nearly completed. About £10,000 have been expended. At King's-road, the works have been almost entirely remodelled, and the most modern improvements have been introduced. A new retort-house has been erected, capahle of producing something like half a million cubic feet of gas per diem. An immense ehimney has heen raised, and condensers upon a new principle have been added. The retort-house is covered with an iron roof, the work being executed by Mr. Williams, and the retorts have been set by Mr. Lloyd, of Waudsworth. Various otber improvements have been effected.

IN WALSALL a further reduction in the previously low price of gas has heen determined on by the Local Gas Committee, the gasworks in Walsall beiug the property of the town, and managed by the Improvement Commissioners.

AT BRIGHTLINGSEA, gasworks have been opened. The expenditure actually incurred has been about £2000, for works somewhat larger than were originally coutemplated, in order to meet an increased consumption in future years without the heavy expense of additional buildings. The works are situate at the bottom of Sydney-street—a new thoroughfare leading to the Hardway. The iron gas-holder will contain 9000 feet. The works were designed by, and carried out under the directiou of, Mr. Church, the engineer. The contractors for the buildings were Messrs. Gull and Lake, of Brightlingsea, and tbe apparatus, machinery, and mains were supplied by Mr. Cliffe, of Huddersfield.

DOCKS, HARBOURS, BRIDGES, &c.

FIRST WIRE SUSPENSION BRIDGE IN BRITISH COLUMBIA.—This suspension bridge crosses Fraser River at a poiut three quarters of a mile below Chapman's Bar, and is admirably situated at a contraction of the river, where the bed-rock rises almost perpendicular on both sides, the towers springing up almost immediately over the water, the bridge having a clear span of 268ft. At low water the roadway of tbe bridge will be 90ft. above the stream. The tower timhers for this work are each 20in. square. Supporting the cables are 16 of these timbers, each 26ft. 6in. long, four timbers being framed together by means of 14 girth timhers and 17 1½in. wrought iron bolts, spread at the bottom, resting on heavy sills, and coming together at the top, forming a pyramid of massive timbers. On the summit is fitted a heavy cast-iron saddle, covering the whole of the timbers, and keeping tbe cable which rests on it in position. These towers, of which there are four, are enclosed in massive granite piers, the piers being 32ft. long by 12ft. wide on top. The two cables are 4½in. in diameter, 528ft. long, and are composed of 1264 wires, laid up in linseed oil, and protected externally by a coating of tar, pitch, and oil boiled together, and payed on while hot; each of these cables weigh 12 tons. These cables are secured on the west side by means of bolts 3½in. in diameter, each set 4ft. into the hard bed rock; and on the east side by means of granite masonry, built underground 60ft. in the hill from the roadway. The cables hang witb a deflection of 20ft. attacbed to each cable. Equi-distant and 5ft. apart are 52 suspension rods, 1⅜in. in diameter, of various lengths, shortening towards the centre in such a manner as to give tbe roadway below a curve of 2ft. rise in the span. Attached to the lower end of these rods and sustained by two nuts are 52 heams, each 17ft. long, 14 by 6in., set up edge-wise. On these beams the platform is built, with 7 sets of stringers, 3 by 10; firmly bridged on tbe top of which is the planking, 4in. thick. This is all bolted togetber by means of ⅝in. bolts, no nails or spikes beiug used in the platform. Attached direct to tbe cables and platform, aud on each side of the bridge is an arrangement of diagonal bracing, very light in appearance, forming an effective truss, and rendering the bridge perfectly rigid. From the platform four wire guys are fastened to the rock on each bank. Tbus, by means of the truss and guys, all undulation or oscillation is prevented. The distance between tbe cables is 14ft. The designer and constructor of this bridge, Mr. A. S. Hallidie, of San Francisco, was on the ground during the entire period of its construction.

AT BELFAST A FLOATING AND A GRAVING DOCK, of extensive size, are about to be constructed, the contractors for the graving dock being Messrs. Thomas Monk & Co., of Birkenhead; and for the floating dock, Messrs. Smitb, Kent, and Browne, of Belfast. The plans and other particulars have been prepared by Mr. Wm. H. Lizars, the resident engineer (under whose immediate supervision the works will be carried on), and approved of by Mr. George Smith, C.E., and conservator of the port and harbour. When these improvements are completed, Belfast will be enabled to give accommodation to a much larger class of vessels than at present, a circumstance that will aid to a great extent the marine interests aud general commercial prosperity of this enterprising port.

NEW BRIDGE AT PEEBLES.—An iron suspension-bridge of one arch, the length of which is about 120ft., has recently been erected near the Tweed at Crownhead, Stobo. The expense of its erection is to be borne partly by the Broughton and Peebles Railway Company, who are to have a station near it, and partly by the landed proprietors of the district. Formerly at this point there was only a ford, with a wooden bridge for foot passengers, the approach to which floods often rendered impassable during winter.

PROPOSED HARBOUR IN THE DOWNS.—A meeting of the promoters of this undertaking has been held in the Guildhall, Deal. Mr. Alfred Giles, C.E., attended aud explained tbe plan of the proposed works. A basin of 30 acres in extent has to be constructed on the waste ground near Sandown Castle, to be connected with Sandwich by a canal 100ft. wide, through which the water of the River Stour can be diverted when necessary to flush out the entrance to the basin. The estimated cost of the works is £200,000. Mr. Giles explaiued that there will be an outer harbour, always open, which will have 10ft. of water at the lowest spring tides, and the entrance to which will be protected with two arms or piers. Tbe works will not interfere with the draiuage of tbe marshes, and the waters of the Stour will be so seldom required for flushing the basin that the river above and below Sandwich will not be injuriously affected.

AN ENORMOUS PAIR OF SHEARS.—Messrs. Tangye, Brothers, and Price, of the Cromwell Works, Parade, Birmingham, have completed, for the Russian Government, an immense pair of sbears, weighing 24 tons, baving a power of pressure equal to 1,000 tons, and ahle to snip to pieces a cold bar of iron half a foot square. The contrivance is technically descrihed as a "horizontal hydraulic shearing machine, with open mouth;" and it is said to be, if not the largest, at least the most powerful article of the kind ever made.

The Mersey Dock Board.—Extension of Dock Accommodation.—After a long and animated discussion at a recent meeting, the Board decided to adopt the recommendations presented by a special committee appointed to consider the new plans for dock works, and to apply to Parliament in the next session for power to borrow a sum of £550,000, to be applied in the making of the purchases, and in the construction of the new dock works on the Liverpool side of the river, included in the plans agreed to by the committee. It was afterwards resolved to increase the amount to £875,000, in order to include the purchase of some additional lands.

Proposed Tunnel under the Mersey.—A plan has been suggested by Mr. T. J. Edwards, Tranmere, to make a tunnel under this river. It would commence on the Cheshire side in the low land at the corner of Camden and Conway-streets, which is only about 26ft. above the level of the Old Dock sill, proceeding thence to the north of the Woodside Landing-stage under the river, and emerging on the Liverpool side at the corner of Whitechapel and Preston-street. The length of the tunnel would be 3400 yards, with descending gradients from the termini to the centre of the tunnel under the river of one in forty. It is also part of the plan to construct a branch tunnel for connecting the goods line with the London and North-Western Railway, passing under Byrom-street at one end, and a connection with the Birkenhead Railways for the goods traffic, and a through passenger traffic from Whitechapel to Chester at the other end. Mr. Edwards estimates that the works may be executed for £400,000.

MINES, METALLURGY, &c.

Mineral Wealth of the Country.—The "Mineral Statistics of the United Kingdom of Great Britain and Ireland for 1862, by Robert Hunt, F.R.S., Keeper of Mining Records," has just been issued in a printed form at the Stationery Office. From this it appears that the total results are as follows for the year 1862:—

Metals produced from British Minerals and Coals.

Gold	5,209 oz.	£20,390	value
Tin	8,476 tons	983,216	„
Copper	14,843 „	1,493,241	„
Lead	69,031 „	1,436,345	„
Silver	686,123 oz.	189,041	„
Zinc	2,151 tons	50,548	„
Iron, pig	3,943,469 „	9,358,672	„
Other metals, estimated		250,000	„
Total value of British metals		£14,281,453	
Coals	81,638,338 tons	20,409,584	value.
		£34,691,037	

Earthy minerals, such as barytes and lime, salt, and the more valuable clays, are estimated at £1,750,000, and we find by a return compiled by Mr. Hunt in 1859, that the value of building stones, slates, &c., amounted to £7,954,075. The actual wealth added to the national store, therefore, as obtained from our native rocks, amounts to nearly £45,000,000 sterling.

Coal-Cutting Machine.—Mr. Delahaye, of Rouen, proposes an apparatus, which consists of a frame, or frames, adjustable to height or length, with the two ends capable of being caused by the pressure of a screw to hold firmly against the top and bottom or partition walls of a mine, or other cavity to be excavated. The frames form guides for slides worked by means of a lever and ratchet, and a pulley with a cord round it, such slides having connected to them, by means of suitable cross-framing, the carriage for the travelling tool, which carriage is supplied with holes for the insertion of a forked bar, or bars, by means of which the carriage may be worked as required along the cross-framing, friction rollers being applied to the carriage in order to facilitate its motion thereon. By means of the foregoing arrangement of apparatus, the operations of the workman will be made to consist in guiding the travelling tool, which will work after the manner of a plane, whereby he will be relieved from the more trying operation of working as usual with a pick.

APPLIED CHEMISTRY.

Carbonate of Soda.—Methods used for Making, Trying, &c.—In 1789 or 1790, Lord Dundonald, Mr. Losh, and Mr. Doubleday, tried, by decomposing common salt by oxide of lead, making the insoluble chloride of lead into a pigment, while the caustic soda formed in the operation was made into carbonate. Another process was by decomposing common salt by sulphate of iron. Sulphate of soda was formed; this, then, heated in a furnace with small coal—sulphide of sodium being formed—they (that is Messrs. Losh) then tried to make the sulphide into carbonate, by burning with sawdust; this was without success. Another process, again, was to form the sulphate by decomposing a mixture of common salt, and sulphate of potash. About this time, the first soda works were erected at Walker, a small village a few miles down the River Tyne, from Newcastle. The partners were Lords Dundonald and Dundas, and J. and W. Losh. Mr. Losh, about this time, got brine from a spring near Walker, and evaporated it down, and then decomposed it by oxide of lead; this was then crystallised. In 1816, Mr. Losh, when in Paris, learnt Leblanc's process for decomposing sulphate of soda, by heating with coal and carbonate of lime; and he was the first to commence the same in England. The greatest disadvantage of this process is that all the sulphur is wasted. Crystals of soda cost then about £60 a ton, now £4 15s. a ton. In 1841, Mr. J. Shanks, of St. Helens, Lancashire, obtained a patent for a process of converting the caustic and silicate of soda in black ash into carbonate, by means of carbonic acid. In 1840, Mr. J. Wilson took a patent for improvements in the manufacture of soda. He applied as much bicarbonate of soda to black ash as would convert the caustic into carbonate of soda. A plan has also been tried for making caustic from the sulphate of soda, by means of caustic baryta. M. Bianc and Bazille patented a soda process, founded on the decomposition of salt by silica at a high temperature, and in the presence of steam. Mr. Wm. Hunt boiled sulphide of sodium with oxide of zinc or copper and caustic soda was formed.

Note on Vegetable Ivory, by Dr. Phipson, F.C.S., &c.—Vegetable ivory is the fruit of the *Phytelephas macrocarpa*, a plant allied to the palm-trees, common in South America. At the period of maturity the grain forms a hard mass resembling ivory or bone, and which is manufactured into various kinds of ornaments. According to an analysis by Muller, its composition may be represented by—

$$C_{24}H_{21}O_{22}=2C_{12}H_{10}O_{10}+HO;$$

Baumhauer obtained a precise similar result some years later. I have found that vegetable ivory takes, in contact with concentrated sulphuric acid, a splendid red colour, almost equal to magenta. This colour, at first pink, then bright red, becomes much deeper and more purple when the acid has been allowed to act for about twelve hours. This reaction may sometimes be found useful in order to distinguish small pieces of vegetable ivory from the ivory of the elephant's tusk, or from bone, neither of which take this beautiful red colour in contact with sulphuric acid. The analysis quoted above show that the greater portion of vegetable ivory is pure cellulose, but the reaction produced by sulphuric acid proves that other substances are present, for cellulose does not become red with sulphuric acid. Mr. Connel found in 1843 that vegetable ivory contained 81·34 per cent. of cellulose, and that the other substances were gum 6·73, legumine 3·80, albumine 0·42 (that is 4·22 of albuminous substances), oil 0·73, water 9·37, and ash 0·61 = 100. Filings of vegetable ivory dried at 140° to 150°C. give 1 per cent. of ash. Payen found that these filings when boiled with caustic soda took a yellow colour, a fact confirmed by Baumhauer, who asserts that potash does not produce any colour. The reaction of sulphuric acid on vegetable ivory has enabled me more than once to distinguish immediately between filings of this substance, and bone or ivory filings. It is owing to the well-known action of this acid upon albuminous substances in presence of sugar, and which has been utilised by Raspail in his microscopic researches. But whether the sugar is formed by the action of the acid in the cellulose, or pre-exists already formed in the substance is of little import. I incline, however, to the first opinion, as the colour takes a little time to show itself (five or ten minutes), and as Mr. Connel did not find any sugar ready formed. I have since observed that the white portion of the cocoa-nut presents a similar reaction with sulphuric acid; the colour produced is first pink, then red, reddish purple, and finally, in about sixteen hours, a fine violet. The colours thus produced with vegetable ivory and cocoa-nut disappear gradually in contact with water, like the fine reddish-brown colour produced with essence of turpentine and sulphuric acid.

On the Extraction of Iron and Steel from the Cinders of Puddling and Reheating Furnaces, by A. L. Fleury.—The thought to give a more practical use to the many thousand tons of cinder that are drawn from the puddling and reheating furnaces, and which are by most of the rolling mills thrown away as useless, or, in the best case, used up as admixture to iron ores in blast furnaces, in order to increase the yield (but certainly not to improve the quality) of the iron, has occupied my attention for several years past. I have made numerous experiments on a practical working scale, and I come now to detail the same in my present communication. Chemical analysis gave me the full assurance that these cinders contain invariably from 25 to 50 per cent. of metallic iron, combined and mixed with sulphur, silica, lime, and alumina, forming a brittle compound of a very peculiar constitution, defying the most ingenious devices of our ironmasters. Near Troy, New York, for instance, near the Troy and Albany Iron Works, are many thousand tons of these puddling cinder spread over the streets, every hundred pounds of which contain from thirty to fifty-five pounds of good iron. After many unsuccessful attempts, I have finally succeeded in extracting good casts, as well as wrought iron, and have even been so fortunate as to produce from this refuse material a good quality of cast steel. Two great difficulties had to be overcome. First. The oxides and metallic iron are in these cinders combined with silica and other substances in such a peculiar way, that, by remelting the same in the puddling, cupola, or other furnace, very little of the metallic iron can be extracted, the combination withstands even to the high heat in a steel crucible—no sufficient per centage of iron can be extracted to make it pay. Second. I have found further, that by re-working the cinder with lime alone, or with lime mixed with charcoal and clay, the product was invariably red-short, and many times red and cold-short (brittle at a bright red heat, as well as when hammered cold.) The sulphur remained still combined with the iron, equally so the silicon and phosphorus—the three devils or evil spirits of iron; all my attempts to extract good neutral iron from the puddling cinder by dry admixture of lime were unsuccessful; there was no other way open but to destroy, or loosen the tenacious chemical combination of these substances before they were placed into the furnace. Unslacked burnt lime has the peculiar property to decompose silicates during the act of hydration or slacking, as it is commonly called. This can easily be demonstrated by pouring water slowly into an intimate mixture of sand and fresh burnt lime—the outside of the sand grains will yield to the lime gelatinous silica, and when fused form with it a strong chemical combination, silicate of lime—the base of a good mortar. Taking advantage of this chemical fact, I mixed a proper per centage of powdered burnt lime with the fine ground cinder, and after wetting the whole with water, exposed the mixture to the drying influence of the atmosphere. The dry compound was then heated in a common puddling furnace, and treated like pig-iron. I obtained 50 per cent. of wrought iron, which, however, retained still some traces of sulphur, leaving the iron somewhat red-short. To extract these last traces of sulphur, I dissolved in the water, which I used for slacking the lime, a small per centage of a chlorine salt, and my expectations were thoroughly realised. The process is also applicable to the working of silicious ores, and can be performed in the puddling, cupola, or blast furnace; it can also be worked to advantage in Bessemer's, Nystrom's, Swett's, and other similar furnaces. The preparation of the cinder, cost of lime, salt, &c., does not exceed two dollars per ton, and the result is, if properly worked, invariably a good quality of iron.

Detection of Sugar in Glycerine.—The suspected glycerine is to be dried as far as possible in a water bath. The glycerine is dissolved out with chloroform, in which sugar is insoluble. The residue, if any, may then be thrown on a filter, washed once or twice with chloroform, and then weighed.—Solubility of Paraffin.—Aug. Vogel has determined the solubility of paraffin in benzol, chloroform, and sulphide of carbon. The paraffin experimented with melted at 48° C., and congealed at 45°. The benzol had the specific gravity 0·887.

The part of benzol at		46° C.	dissolved	7·7	parts paraffin.
„	„	43°	„	5·0	„
„	„	39°	„	4·0	„
„	„	23°	„	0·7	„
„	„	20°	„	0·3	„

Solubility in Chloroform.—One part of chloroform at 23° dissolved 0·22 parts paraffin. One part of chloroform at 20° dissolved 0·16 parts paraffin. Solubility in Sulphide of Carbon. One part of sulphide of carbon at 23° dissolved an equal weight of paraffin. Comparative experiments with stearic acid showed that one part of benzol at 21° C. dissolved 0·22 parts of stearic acid; and one part of sulphide of carbon at 23° dissolved 0·3 of stearic acid. This acid is consequently less soluble in the above menstrua than paraffin. A mixture of stearic acid and paraffin fused together did not separate from these solutions in a homogeneous mass, but in two layers, the stearic acid appearing in distinct crystals. This may suggest a method of recognising the presence of stearic acid in a mixture with paraffin.

Finely Divided Iron and its Application for the Precipitation of Copper from Solutions and other Purposes.—Mr. Gustav Bischof, of Skelly, near Swansea, has built a reverberatory furnace of his construction at the works of Messrs. Roberts, Dale, and Co., Warrington, for the production of finely divided iron, by heating a mixture of pulverised oxide of iron and carbonaceous matter, avoiding fusion. The powdered iron thus obtained is used for the precipitation of copper from its solutions in the manufacture of aniline instead of iron filings, and for other purposes. In the manufacture of aniline, iron filings may be used as usual, which, having been oxidised, are re-converted into the metallic state as described, thus being employed over and over again. For the precipitation of copper; Spanish or Irish burnt ores, containing a few per cent. of copper are reduced in the above furnace. Both iron and copper in these ores are converted into the metallic state, and being employed for the process of precipitation, the latter mixes with the copper precipitated from solutions. As by these means the whole copper contained in the burnt ores is extracted, the greater value of such copper to the price paid for the ores fully covers the costs of purchase and reduction, even leaving in most cases a considerable surplus. Trials made with the precipitation of copper from artificial solutions and [illegible] water by Mr. Bischof have amply proved the powerful action of such iron [illegible]. This process therefore combines the saving of all costs for iron with a greatly [illegible] precipitation.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated October 23rd, 1863.

2617 J. Ronald—Spinning hemp, flax, manilla, and wool.
2618 V. J. Cassaignes—Prisms, lenses and glasses of stereoscopes, and ornamenting glass.
2619 F. Tolhausen—Regulating the working of springs.
2620 J. Parker—Application of steam combined with air as a motive power.
2621 A. V. Newton—Railway wheels.
2622 A. Wardle & J. Brindley—Improvements in smoking pipes.

Dated October 24th, 1863.

2623 W. Betts—Metallic capsules for bottles and similar vessels.
2624 E. S. Crease—Drilling, boring, or excavating rock or other earthy substances.
2625 J. Davidson—Doubling yarns or threads of silk.
2626 J. Thomas—Improvements in gas meter indicators.
2627 G. Haseltine—Attachment to coverings for the head and to other articles of dress for lighting matches.
2628 F. B. Baker—Dressing lace and other textile fabrics.
2629 J. Brown, J. T. Way, & T. M. Evans—Preparing cements and varnishes.
2630 W. Locke, J. Warrington, W. E. Carrett, W. E. Marshall, & J. Telford—Working and mining coal, minerals, and earthy matters.
2631 L. J. Hannart—Fastening for gloves and other wearing apparel.
2632 A. & W. P. Potter—Improvements in railway waggons.
2633 A. Sellar—Improved instrument for lubricating rifles.
2634 B. Brown—Sewing machines.
2635 A. Alison—Atmospheric railways, and carriages for the same.

Dated October 26th, 1863.

2636 R. Littlehoy—Improvements in the manufacture of nosebags.
2637 B. Steinmetz — Improvements in locks for bags.
2638 F. Parker—Carriages.
2639 T. Marsh—Projectiles.
2640 S. J. Healey—Water gauges applicable to steam boilers and other purposes.
2641 M. Vian — Composition for preserving iron ships.
2642 J. Nicholas — Treating Canadian petroleum and other mineral oils.
2643 W. E. Gedge—Improved pillow.
2644 I. Baggs—Capturing or killing fish, birds, and other animals.
2645 J. Willcox—Sewing machines.
2646 A. Blake—Refrigerator for cooling worts for brewing.
2647 E. Clifton & B. Greenwood—Manufacture of brushes.

Dated October 27th, 1863.

2648 J. Marshall—Expression of oil from oil-yielding substances.
2649 T. H. Holderness—Improvements in propelling navigable vessels.
2650 J. C. Wilson—Mounting, firing, cleaning, and loading ordnance.
2651 T. Grason—Boots, shoes, clogs, and such like coverings for the feet.
2652 E. G. Atherley—Obtaining motive power by certain arrangements of machinery and water.
2653 W. Livingstone — Punching, shearing, and rivetting metals.
2654 J. Hutchinson & J. Hollingworth—Weaving.
2655 P. B. O'Neill—Salinometer.
2656 R. Smith—Doubling and winding machines.
2657 E. R. Hollands — Punching, cutting, and pressing metals and other materials.
2658 M. W. Carr—Manufacture of wooden sleepers for railways.
2659 W. & S. Firth & J. Sturgeon—Cutting and boring coal, stone, or other minerals.

Dated October 28th, 1863.

2660 W. Wanklyn — Opening and conditioning cotton.
2661 J. Marshall—Applying adhesive substances to spindles.
2662 A. S. Coronel—Preparation of tobacco for fumigating purposes.
2663 W. E. Gedge—System of permanent advertisement.
2664 S. Procter—Instrument for extracting corks from bottles.
2665 E. Oldfield—Self-acting mules for spinning and doubling cotton.
2666 H. A. Bonneville—Clasps for portemonnaies, pocket books, and bags.
2667 R. Needham & J. Pollitt—Equilibrium valves for steam engines.
2668 J. & J. Cavenah—Making bricks and tiles.
2669 M. Henry—Military knapsacks and travelling bags.
2670 W. Hall — Ornamenting glass and sheet gelatine.
2671 G. E. Donisthorpe—Getting coal and other minerals.
2672 R. B. Jones—Portable cooking apparatus.
2673 J. Kennedy—Ships of war and other vessels, and masting and rigging the same.
2674 R. A. Brooman—Taking astronomical and other observations.
2675 R. A. Brooman—Clocks, watches, and other timekeepers.

Dated October 29th, 1863.

2676 O. C. Evans—Digging machinery.
2677 J. R. Johnson—Manufacture of lubricating compounds.
2678 J. Rawlings — Attaching cords to window sashes.

Dated October 30th, 1863.

2679 A. R. Le Mire Normandy—Playing cards.
2680 F. N. Gisborne—Coating ships bottoms.
2681 J. Nash—Mattress.
2682 J. Haworth—Conveying electric signals.
2683 H. Cochrane—Surface condensers.
2684 W. M. Neilson—Taps.
2685 W. Gadd—Bonnet and cap fronts.
2686 F. Durand—Cotton gins.
2687 M. J. Roberts—Oiling wool.
2688 G. Rosselet—Sustaining and raising ships.
2689 A. Turner & W. E. Newton—Looms.
2690 B. Russ—Iron and other ships.
2691 A. Turner—Looms.
2692 W. Verran—Obtaining motive power.
2693 H. Clow—Ovens.
2694 G. F. Bushbridge—Feeding sheets of paper to a drying machine.
2695 J. Brigham & R. Bickerton—Reaping and mowing.
2696 J. H. Johnson—Soap.

Dated October 31st, 1863.

2697 H. B. Barlow—Wool and hair felting.
2698 A. Wasserburgen & T. Lessunger — Show cards and window tickets.
2699 S. H. Parkes—Opera glasses, telescopes, microscopes, spectacles, and other optical instruments.
2700 W. Tasker—Making safety paper.
2701 J. Renning—Chandeliers and lamps.
2702 W. Law—Furniture.
2703 J. Getty—Building ships and vessels.
2704 J. H. Brown—Securing envelopes and other packages.
2705 W. Pope—Crushing stone.
2706 J. Wilson—Thrashing machines.
2707 S. Holman—Raising and forcing fluids.
2708 E. Jones—Bricks, drain pipes traps, sewage tanks, and water closet pans and valves.

Dated November 2nd, 1863.

2709 T. Adams & J. Scott—Transmission of patterns or samples of merchandise by post.
2710 F. J. Vandenvinne—Excavating land.
2711 W. E. Newton—Clock-work movements.
2712 T. F. Wintorn—Ventilators and fire-guards.

Dated November 3rd, 1863.

2713 T. W. Alderton—Sewing machines.
2714 F. J. Pastorelli—Surveying instruments.
2715 D. Davy—Steam hammers.
2716 J. Macintosh—Taps or cocks.
2717 R. Eaton—Ruling or marking leather.
2718 S. Bateman—Combing wool and other fibrous substances.
2719 J. P. Booth—Beds and bedding.
2720 J. J. Revy—Explosive compounds.
2721 M. Henry—Zinc white.

Dated November 4th, 1863.

2722 J. Livesey & J. Edwards—Permanent way of railways.
2723 P. A. Santreuil—Lubrication of bearings.
2724 G. Vile—Treating natural phosphates of lime.
2725 J. Thomas—Preparing ores and earths containing copper for smelting.
2726 E. Hughes—Fans for forcing and exhausting air or other gases.
2727 E. Howe—Sewing machines.
2728 J. Tangye—Portable hydraulic shearing and rivetting machines.
2729 R. Brooks & C. Inwards—Facilitating the teaching and playing of stringed instruments.
2730 A. Gillett—Cutting chaff.
2731 J. A. Barral & L. A. Cochery—Manure.
2732 J. H. Maw—Application of preservative coatings to the bottoms of ships.
2733 W. Audinwood—Thrashing machines.
2734 M. Luneau—Hat or cup frames.

Dated November 5th, 1863.

2735 G., W., & J. Craven—Cutting and planing iron and other metals.
2736 J. Northrop—Fringes.
2737 E. K. Dutton—Covering the surfaces of rollers or cylinders.
2738 T. Farra — Skirtings employed as wearing apparel.
2739 R. Smith—Colouring matters.
2740 B. Blackburn—Coupling or buckle.
2741 W. Proger—Lanterns.
2742 H. Hancock & W. H. Vickers—Fastenings.
2743 J. Whitworth—Treatment and application of steel and homogeneous metal.
2744 H. Bessemer—Railway bars.
2745 S. Smith—Safety valves.
2746 H. Bessemer—Iron and steel.
2747 R. T. Tait—Woollen garments.
2748 G. Speight—Collars and cuffs.
2749 F. E. Sickles—Steering vessels.

Dated November 6th, 1863.

2750 C. D. Abel—Fluid meters.
2751 C. Coates—Printing cotton.
2752 R. Sellar—Harrows.
2753 J. Muckart—Preserving vegetable substances.
2754 W. Davies & G. Cate—Cutting corks.
2755 C. H. Southall & R. Heap—Cutting and shaping the soles and heels of boots and shoes, and screwing them on to the uppers.
2756 R. Saunders—Fastening together the parts of ships and vessels.
2757 J. S. Garrette—Inhaling apparatus.
2758 J. Townsend—Nitrate of potash.
2759 W. M. Neilson—Axle boxes.
2760 W. D. Allen—Casting steel.
2761 C. M. Campbell—Drying earthenware.
2762 W. H. Perkin—Colouring matters.
2763 R. Johnson—Testing the strength of wire.
2764 W. E. Newton—Sewing machines.

Dated November 7th, 1863.

2765 H. L. Emery—Ginning and cleaning cotton.
2766 T. C. Barraclough—Looms
2767 R. Batt—Paper-making machinery.
2768 J. K. Hoyt—Revolving fire-arms.
2769 J. Johnson—Lubricators.
2770 J., J., & G. W. Dyson—Forming metal plates, bars, and rods taper.
2771 L. Braham—Spectacles and hand frames.
2772 W. Clark—Sewing machines.
2773 G. S. Melland—Fire-arms and ordnance.
2774 A. Prince—Sewing machines.
2775 A. Barclay & A. Morton—Injecting and ejecting fluids.
2776 C. D. Abel—Raising and lowering bodies.
2777 H. Wickens—Lamps.
2778 M. Mellor—Looped or knitted fabrics.
2779 G. Haseltine—Bending metallic pipes.

Dated November 9th, 1863.

2780 A. A. L. P. Cochrane—Propelling and steering ships.
2781 H. Mege—Soap.
2782 W. J. Cunningham & H. Connop—Sawing machines.
2783 G. T. Bousfield—Ships and vessels.
2784 N. Thompson—Stopping bottles.
2785 G. Ryder & M. Gutteridge—Hay making machines.
2786 R. H. Philipson & J. Dees—Cutting coal.

Dated November 10th, 1863.

2787 T. Weston—Printing presses.
2788 J. C. Habicht—Keyless watches.
2789 G. Yates—Heel and toe tips.
2790 J. Ramsbottom—Measuring and registering fluids, and obtaining motive power from the same.
2791 S. J. Bartlett—Taps
2792 H. A. Bonneville—Chimney pot.
2793 F. Castelnau—Two-wheeled vehicles.
2794 J. Mash—Safety valves.
2795 S. Faulkner, J. Berry, & G. Harrison—Grinding cards.
2796 S. Faulkner—Carding engines.
2797 J. Cutler—Fountains.

Dated November 11th, 1863.

2798 F. Testuz—Railway breaks.
2799 J. Smith—Finishing woven fabrics.
2800 W. R. Bowditch—Gas-lighting.
2801 T. M. Rende & J. Hewitt—Regulating the supply of water to water-closets.
2802 J. Fottrell—Deodorising petroleum.
2803 D. Dawson—Colours for dyeing.
2804 Anne Catherine, widow Durst Wild—Hats and bonnets.
2805 H. Melton—Shakos, military and other hats and caps
2806 W. D. Richards—Engines.
2807 M. Stainton & D. Lawson—Steering ships.
2808 W. Clissold—Opening, cleaning, preparing, and carding wool
2809 G. Haseltine—Endless chain horse powers.

Dated November 12th, 1863.

2810 B. A. Murray—Doubling, hoisting, and winding silk
2811 H. J. Simlick—Fusees.
2812 A. Craig—Distilling hydro-carbons.
2813 B. Peake—Neckties, cravats, and waistbands.
2814 J., J., & J. Booth—Cranes.
2815 A. Illingworth—Twisting cotton and wool.
2816 H. Holden—Shuttles for weaving.
2817 G. Davies—Springs for railroad cars.
2818 E. Rowland—Weighing solid bodies.
2819 W. E. Gedge—Amalgamating precious metals.
2820 D. Ford—Propelling boats and barges.
2821 G. H. Brockbank—Pianofortes.
2822 L. E. C. Martin—Generating steam.
2823 W. E. Newton—Gas burners.
2824 P. Bettle—Pins, brooches, and buckles.
2825 D. M. Fyfe—Carriages.

Dated November 13th, 1863.

2826 C. W. Siemens—Submerging telegraph cables.
2827 B. Marriott & C. Radcliff—Watches.
2828 W. Robertson—Spinning and doubling.
2829 W. Chambers—Finishing cloth.
2830 G. Remington—Railways and engines.
2831 H. F. Honson—Cigars.
2832 W. F. Dearlove—Separation of animal and vegetable substances.
2833 E. Spencer & J. Dodd—Mules.
2834 J. W. Drummond—Looms
2835 G. K. Geyelin—Water closets.
2836 G. T. Bousfield—Apparatus used when rolling blinds.
2837 T. Harrison—Excavating coal.

Dated November 14th, 1863.

2838 M. A. Muir & J. M'Ilwham—Looms.
2839 J. Medway & S. Joyce—Colouring matter.
2840 H. Gladstone—Skin cartridges.
2841 De B. Hughes—Producing dramatic effects.
2842 J. P. Binns—Sewing machines.
2843 J. Ellison—Silk reels.
2844 J. C. Wilson—Cotton gins.
2845 E. T. Hughes—Sewing machines.
2846 E. Hargraves—Preventing the escape of heat from steam boilers.
2847 A. Ellissen—Preventing the fouling of ships.
2848 T. S. Prideaux—Armour.
2849 G. Barker—Syphons.
2850 W. A. Lyttle—Covers for umbrellas.
2851 G. H. Courtney—Tills.
2852 W. E. Newton—Iron and steel.
2853 G. Lindemann—Singeing fabrics.
2854 J. Lewis—Rudders.
2855 L. Mackirdy—Cleansing charcoal.
2856 R. A. Brooman—Printing.
2857 J. Harrison—Cleaning cotton seed.
2858 R. A. Brooman—Engines and boilers.
2859 J. Southgate—Portmanteaus.
2860 T. Williams & I. Naylor—Paper spools.
2861 J. Walmsley—Cleaning the soil.
2862 J. Hulse & J. Lawrence—Attaching door knobs.

Dated November 16th, 1863.

2863 E. & F. A. Leigh—Driving cotton gins.
2864 C. Pengilly—Pulverizing ores.
2865 S. Cameron and W. Johnston—Taps.
2866 G. Thonger — Preventing accidents arising from the sale of poisons.
2867 E. W. Elmslie—Cottages.
2868 R. Griffiths—Propelling ships.
2869 A. P. Henry and R. T. Power—Affixing labels.
2870 G. T. Bousfield—Cartridges.
2871 I. Pomes—Hydraulic motor.
2872 J. J. Maurer—Towing boats.
2873 L. L. Sovereign—Cultivating land.
2874 C. W. Harrison—Filters.
2875 R. A. Brooman—Salt.

Dated November 17th, 1863.

2876 P. M. Parsons—Ordnance.
2877 F. W. Burton—Music stools.
2878 W. Cowan—Gas meters.
2879 V. Baker—Ordnance.
2880 J. Betteley—Sheathing ships.

Dated November 18th, 1863.

2881 W. Pratchitt, J. Blaylock, and J. Pratchitt—Movable platforms.
2882 T. C. Kimpton—Time, fare, and distance apparatus.
2883 R. Mayer—Fire-arms.
2884 J. H. Johnson—Rotatory engines.
2885 R. W. Siever—Jacquard machines.
2886 W. M. Williams—Distillation of coal and peat
2887 J. R. Cooper—Barrels for fire-arms
2888 W. Wigtall and G. Jolly—Explosive compound
2889 J. Elder—Docks
2890 J. Stewart—Steam boilers
2891 J. Mackew—Looped fabrics
2892 E. C. Nicholson—Colouring matters
2893 J. G. Jennings and M. L. J. Lavater—India-rubber tubes, rings, and cords
2894 H. Hirzel—Colouring matters
2895 P. Saint G. Græme—Vessels of war

Dated November 19th, 1863.

2896 W. B. Adams—Wheels, tires, axles, and axle boxes
2897 J. Eglin—Drifts
2898 J. Elder—Steam engines
2899 A. G. Southby—Distillation of petroleum
2900 A. Balny—Stopping horses instantly
2901 I. Francis—Cleaning coal and coke
2902 W. H. Gray—Blast cylinders
2903 J. Kirkham—Treatment of ores
2904 E. Walker—Windlasses
2905 J. Collyer—Closing orifices in casks
2906 R. and J. S. Walker and B. Brown—Preparing cotton to be spun
2907 E. Christmas—Carriages
2908 W. Symons—Working of railways
2909 R. Gooch—Sheeting piles
2910 J. Colling and D. G. Pinkney—Reefing and furling ships' square sails
2911 W. B. Hodson—Cans for holding oils

Dated November 20th, 1863.

2912 G. Rait and J. Winsborrow—Gas meters
2913 J. Seward and H. Smith—Preventing incrustation in steam boilers
2914 E. Marwood—Covering rollers used in spinning and preparing cotton
2915 B. Dobson, E. Barlow, and P. Knowles—Ginning cotton
2916 E. Pezold—Pipe stick
2917 C. Stevens—Hoisting and lowering apparatus
2918 A. H. Ferry—Pianoforte hammers
2919 J. J. Hays—Hot-air stoves
2920 G. S. Kirkman—Connecting railway carriages
2921 T. Brinsmead—Thrashing wheat
2922 A. M'Laine—Gun boats, gun vessels, and rams
2923 G. Fawcus—Connecting scaling, firing, and other like ladders
2924 W. E. Newton—Fan blowers
2925 W. E. Newton—Attaching labels to bales
2926 H. A. Bonneville—Preserving grain and flour
2927 J. H. Johnson—Steam engines
2928 C. E. Wright—Binding together letters and music

Dated November 21st, 1863.

2929 T. Turner—Fire-proof floor or roof for buildings, bridges, and other structures
2930 H. Ayckbourn—Cultivation of oyster spawn and brood
2931 F. Fenton—Treatment of vegetable fibres
2932 W. Williams—Bricks
2933 D. Cope—Metallic drums, kegs, casks, and cylindrical packages
2934 L. D. Estienne de Saint Jean—Shutting gates
2935 E. Finch—Floors of bridges and houses
2936 F. Watkins—Bolts, nuts spikes, and rivets
2937 A. Simoneton—Linen cloth
2938 T. Humphreys—Strings for tying up fire wood
2939 D. W. Hamper—Mashing malt
2940 M. B. Westhead—Tapes and threads
2941 J. Steart—Extracting fibre from zostera marina

Dated November 23rd, 1863.

2942 W. Bestwick—Braiding machines
2943 C. Howard—Watch case pendant
2944 P. Bawden—Bricks
2945 J. Smith—Covering the bottoms of ships
2946 E. B. Wilson and J. Imray—Presses
2947 T. Carr—Intermixing dry, semi-fluid, or aqueous materials
2948 J. Platt—Cultivating land